金沢

BIODIVERSITY IN KANAZAWA

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THROUGH THE FOUR SEASONS

TABLE OF CONTENTS

NATURE IS CLOSER THAN YOU THINK

The effective conservation of biological diversity, at present, appears to be an insurmountable challenge for the international community. At the tenth meeting of the Conference of the Parties to the Convention on Biological Diversity, held in Aichi-Nagoya, Japan between 18-29 October 2010, the peoples of the world were informed of the fact that we have collectively failed to significantly reduce the rate of biodiversity loss in the past decade. The reasons for this failure are complex. However, it is perhaps no coincidence that since 2008, for the first time in history, more than half of the world's population is now living in towns and cities. While living in an urban environment does not necessarily imply a larger ecological footprint or greater responsibility for biodiversity loss for each and every citizen, it does suggest that the connections urbanites have with, and perhaps also their appreciation of, biological diversity is somewhat diminished. This diminishing awareness implies that they are less conscious of the consequences of their actions in terms of the impacts on biodiversity loss. But does this need to be the case? Perhaps an important way to rediscover the value of the linkages with biological diversity for urban dwellers could be through an exploration of the interconnectedness between biological diversity and local culture.

There is a new term for this – bio-cultural diversity. It has been defined by UNESCO as "the myriad ways in which humans have interacted with their natural surroundings. Their co-evolution has generated local ecological knowledge and practices: a vital reservoir of experience, methods and skills that help different societies to manage their resources. Diverse worldviews and ethical approaches to life have emerged in tandem with this co-evolution of nature and culture. The biocultural concept is critical to making progress on building mutual understanding and support between these two diversities."

These "two diversities" refer to biological diversity and cultural diversity (UNESCO 2010). This publication builds on insights from the important work of UNESCO and the Secretariat to the Convention on Biological Diversity and their efforts to raise awareness of the links between the two forms of diversity and the implications for human and environmental prosperity. The report is based on a long-term collaboration between the Kanazawa City Government and the United Nations University.

An exploration of the interaction between biological and cultural diversity in relation to Kanazawa is relevant for several reasons. First, in recent years, there has been increased attention to the need to consider the inter-linkages between biological and cultural diversity for the effective conservation of both. However, despite the

recognition given to the impact of cities (and urbanization processes) on biodiversity and thus to the role of cities in biodiversity conservation, little attention has been given to bio-cultural linkages in an urban context. At the same time, as globalization advances, cities are increasingly in danger of losing their cultural identity.

Second, it is the smaller cities (with a population of around half a million inhabitants) that are likely to see most growth in the future across the world. Hence, the relevance of a focus on a regional city like Kanazawa and the lessons it may have for other developing regional cities facing similar challenges in preserving their biodiversity and cultural identity as they develop.

Third, in Japan, Kanazawa is a city particularly recognized as a cultural centre. This culture takes various forms, from citiscape, to literature, to traditional crafts, to cuisine. In 2009, it was designated as a UNESCO Creative City in the field of crafts. But there is less awareness that the richness of Kanazawa's culture is inextricably linked with the rich diversity of its environment, which consists of both terrestrial ecosystems (alpine forests, managed broadleaf deciduous forests, fertile plateaus and plains, sand dunes), and aquatic ecosystems (rivers, ponds, canals, a lagoon and the sea).

Fourth, municipal policies in Kanazawa over the years have sought to reflect and enhance this diversity, including in urban planning, and often from a "cultural identity" perspective (e.g.: forested green slopes, rivers and canals have been preserved because they were considered part of the "traditional landscape" of the city).

Fifth, there is a strong interest in biodiversity and bio-cultural diversity on the part of the local government, which facilitates data collection, willingness to participate in interviews, etc. The city hosted the official closing of the International Year of Biodiversity in 2010.

As part of the collaboration between Kanazawa City, UNU Institute of Advanced Studies Operating Unit Ishikawa/Kanazawa (UNU-IAS OUIK) and the UNU Media Centre, a 54-minute video documentary entitled *Book of Seasons – A Year in Kanazawa* was produced and screened at an Environmental Film Festival in Kanazawa on 17 December 2010. Since the establishment of UNU-IAS OUIK in 2008, the city of Kanazawa has functioned as both the host location and the site for field research. This report elaborates on the narrative presented in the video documentary. It begins with essays on the seasons in Kanazawa City and the interconnections with various local cultural traditions. As some commentators have pointed out, the seasons (*shiki*)

are a powerful explanatory factor underpinning interactions with nature in Japanese culture (Ackerman 1997) and this certainly is true with respect to the experience of nature in Kanazawa, going back to the times when there were 24 seasonal days to mark the change in seasons in the traditional calendar. The report then moves on to explore from a more academic perspective the interactions between cities and biodiversity. The final section looks prescriptively at the lessons that can be drawn from Kanazawa's experience of managing various local ecosystems.

The main lesson is that the richness of any local culture is a direct reflection of the depth of interaction that people have with, and their appreciation of, the local biodiversity. As such, it can also be surmised that not caring about biodiversity loss equates with a willingness to allow your culture to be diminished now and in the future. Few of us would accept either the loss of culture or biodiversity when presented in these terms. Yet, we do. The challenge therefore is to raise awareness of the fundamental inter-linkage between culture and biodiversity amongst the largest segment of the urban population. For this to work it has to be grounded in actual observations from the field, in this case Kanazawa, that can support any scientific and theoretical propositions.

KANAZAWA

Geography

Kanazawa City, the capital city of the Ishikawa Prefecture, covers an area of 467.77 square kilometres, extending 37.3 kilometres from north to south and 23.3 kilometres from east to west. Lying on the northwest side of Honshu, Japan's main island, it is framed by the Sea of Japan to the west, Mount Haku to the south, the Japan Alps to the east and Noto Peninsula to the north. From Mount Naradake rising 1,644 metres high at the city's southernmost tip, the terrain changes to the sloping hills of Uta-tsuyama and Nodayama, descending further towards the flat area of the Kanazawa Plain. All across its length, the city is crossed by two rivers, the Asano and Sai, which rise from the mountains in the back, carving the hills into three distinct plateaus before they empty into Kahoku Lagoon and the Sea of Japan. Its geographical location gives Kanazawa a temperate climate, with each of the four seasons colouring the landscape in different shades. The climate is one of the wettest in Japan, with a humidity of 73 per cent and an average of 178 rainy days each year. In winter, skies are mostly overcast and the city receives large volumes of snow carried by the northwestern monsoons. Large differences in altitude also influence the local climate.

History

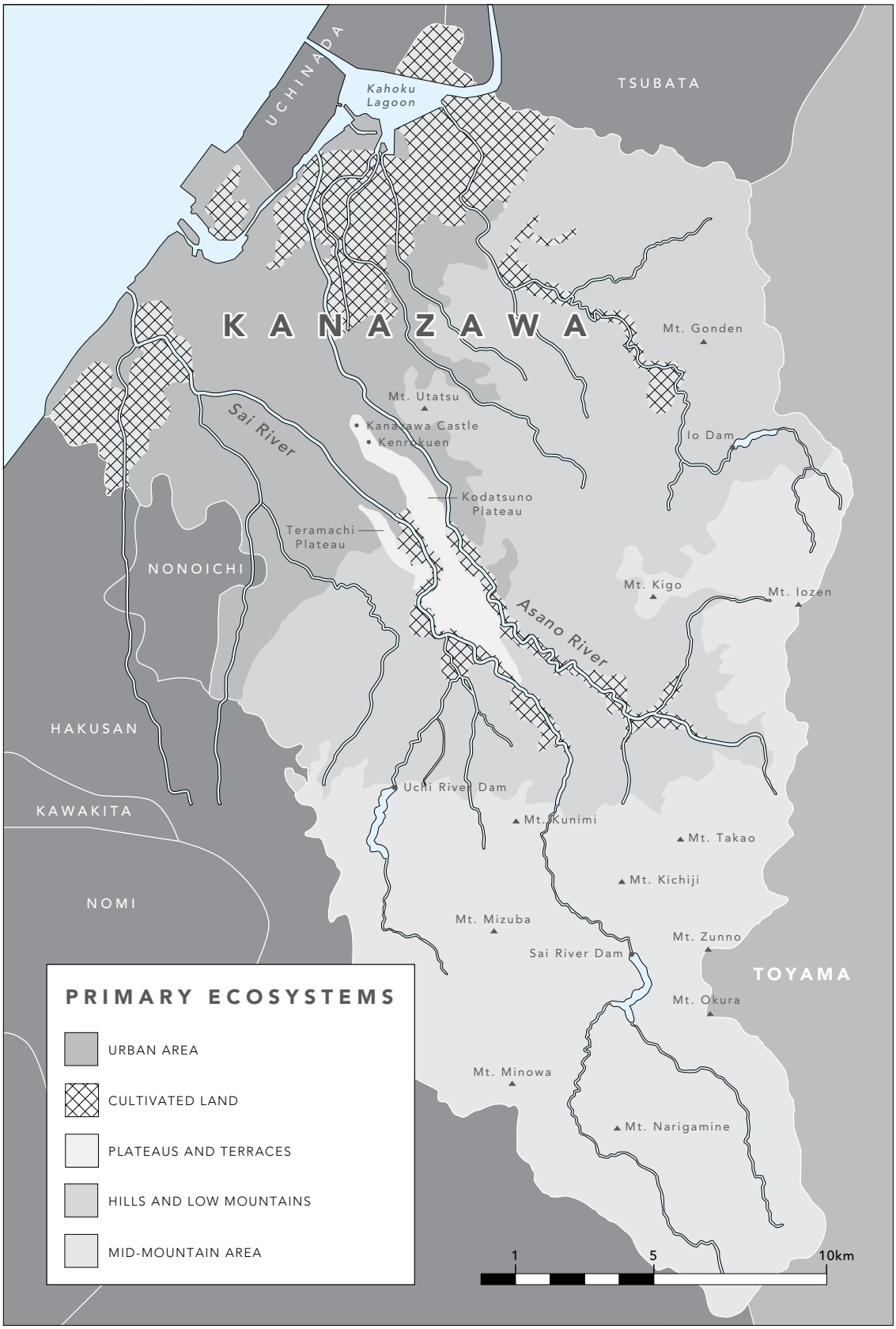
The city's history goes back to the mid-sixteenth century, when followers of the Ikko school of Pure Land Buddhism built the Oyama Gobo temple on a rise of land between the Sai and Asano Rivers, right at the tip of the Kodatsuno Plateau, establishing an autonomous religious government in the area. In 1583, the temple came under the control of Maeda Toshiie, head of the Maeda clan, who raised his castle on the former temple grounds. The city of Kanazawa grew around the castle, with the residences of the highest-ranking retainers in its close proximity, streets lined with merchants' shops and several districts assigned to crafts and trades still evoked today by names such as the Lumber District. The Maeda were among the

wealthiest and most powerful feudal leaders of the Edo period, with a domain comprising the three provinces of Kaga, Etchu and Noto. A culture of refinement and elegance developed in Kanazawa under the patronage of the Maeda clan leaders. Master artisans were invited from Kyoto as instructors in metalwork, gold-leaf lacquer ware, silk dyeing and ceramics. Performing arts, the tea ceremony and Confucian learning flourished, as did Buddhism. Two temple quarters, which also had a defense function, were strategically located on the two sides of the castle, with about 70 temples in the Teramachi area across the Sai River and 50 on the Asano River at the foot of Utatsuyama. After the Meiji Restoration of 1868, when Japan opened to the West and the clan system was abolished, the decline of the warrior class that had supported Kanazawa's flourishing culture led to a rapid fall in the city's population. The city would start recovering its vitality towards the end of the nineteenth century, when new opportunities emerged with the rise of the local textile industry.

Seasons

In Kanazawa the passage of the seasons never ceases to surprise the onlooker with the ever-changing variety of the landscape. Each season has its own distinctive character, from the dramatic skies of winter, to the blossom-covered hillsides of spring, the lush green flooding the city in summer and the crimson carpets of fallen leaves in autumn. The faces of nature in Kanazawa are never static, as each season grows slowly towards its peak and then transforms and fades seamlessly into the next. The rhythms of the seasons and their locally-specific manifestations have had a profound structuring influence on the interactions between the citizens and their natural environment.


JAPAN
ISHIKAWA
TOKYO
KYOTO
ISHIKAWA PREFECTURE
Sea of Japan
KANAZAWA
TOYAMA
GIFU
FUKUI


UCHINADA
Kahoku Lagoon
TSUBATA
KANAZAWA
Mt. Gonden
Mt. Utatsu
Kanazawa Castle
Kenrokuen
Sai River
Io Dam
Kodatsuno Plateau
Teramachi Plateau
NONOICHI
Mt. Kigo
Mt. Iozen
Asano River
HAKUSAN
Uchi River Dam
KAWAKITA
Mt. Ikunimi
Mt. Takao
Mt. Kichiji
NOMI
Mt. Mizuba
Mt. Zunno
Sai River Dam
TOYAMA
Mt. Okura
Mt. Minowa
Mt. Narigamine
PRIMARY ECOSYSTEMS
URBAN AREA
CULTIVATED LAND
PLATEAUS AND TERRACES
HILLS AND LOW MOUNTAINS
MID-MOUNTAIN AREA
1
5
10km

WINTER

In winter, Kanazawa bears witness to rain and snow in their myriad forms. The beginning of winter is signaled by thunderstorms reverberating against the mountains. They are said to "awaken" not only the snow (*yukiokoshi*), but also the shoals of yellowtail (*buriokoshi*) that start their seasonal migration southward along the coast. Moisture-laden winds blowing across the Sea of Japan hit the slopes of the Japan Alps and rise high into the colder strata of the atmosphere, where the vapor condenses falling over Japan's northern coasts in various forms of precipitation. Seemingly never-ending rains that have been drenching the streets and black tile roofs all day suddenly metamorphose into fine drizzle. As the night engulfs the city, the twisting silhouettes of lightning and the sound of thunder give way to hail and sleet pouring down as if the skies have broken apart.

Many features of Kanazawa's cityscape have developed in response to the winter climate. Traditional houses in the city have low projecting eaves to provide protection from wind, rain and snowfall. The streets have long been equipped with canals into which the piling snow can be cleared. Ingenious methods have been devised to make ornamental gardens withstand the weight of accumulated snow, while also highlighting its special beauty. But not only the form of the city has been shaped by the characteristics of the climate. Long winter months spent indoors have had a formative impact on the city's richness of crafts and performing arts. Some of the artifacts, such as Kanazawa's paper umbrellas, have been created especially as solutions to the challenges posed by the climate. A large variety of preserved foods have been produced for the winter season. As the city kept adapting to its environment, a cultural landscape became superimposed over the natural landscape and a distinct material culture developed.

Kenrokuen: A cultural landscape at the heart of the city

The grey of the low-hanging sky is washed with the white brush strokes of large, soft snowflakes known as 'peony snow' (*botan yuki*), blown by the wind from every direction. In the centre of Kanazawa, where the land suddenly rises into the slopes of a plateau, the ancient stone walls of Kanazawa Castle and the trees overhanging them seem traced in the monochromatic tones of ink paintings. On the adjacent hill, some eight thousand trees are hibernating under the heavy snow in Kenrokuen, the Castle's outer garden. Their branches bend with the weight of the snow over the landscaped pathways and ponds.

Each year before the onset of winter, poles are erected among the branches of the trees in Kenrokuen and rice-straw ropes suspended from their tops are attached to the branches to provide support against the snows of the Sea of Japan coast. These canopies of ropes, known as *yukitsuri*, shroud not only the vast aged trees, but also fragile younger trees and bushes. The practice of using ropes to protect the trees in winter is mentioned in records dating from the late Edo period (1603-1868). In addition to preventing snow damage, *yukitsuri* arrangements add to the aesthetics of the landscape, forming together with the trees elegant architectural structures.

The conical veils of ropes are part of the winter scene in Kenrokuen, with its pictorial composition of snow-covered pines, teahouses, bridges and stone lanterns reflected in the still mirror of the ponds.

Cultural values influencing the landscape

The current design of Kenrokuen is the result of two centuries of imaginative remodeling of nature by the master gardeners of the feudal era. Originally built as the private garden of the Maeda clan who ruled the Kaga domain, Kenrokuen developed from a small garden around a villa on the slope facing the castle, where the lord entertained important guests and chief retainers, and held maple-leaf viewing banquets in autumn. Over the years, the garden was transformed to reflect the tastes of the successive generations of clan lords and was gradually enlarged, currently covering about 10 hectares. After the clan system collapsed at the beginning of the Meiji period (1868-1912), Kenrokuen became a public park.

Kenrokuen is a spatial illustration of how the diversity of nature and the diversity of culture interact to create unique, place-specific forms. Despite the appearance of naturalness, which it shares with other traditional Japanese gardens, Kenrokuen is nevertheless an artificially created garden, a world unto itself, which does not merely reproduce natural beauty, but gives expression to an idealized nature. The various elements of vegetation, topography and climate have been artistically incorporated into the design to enchant and surprise the senses. In Kenrokuen, a cultural landscape has been worked into the natural landscape over the centuries, based on aesthetic, philosophical and religious ideas and values.

Some of the garden's features reflect aesthetic notions derived from Japan's centuries-long cultural exchange with the mainland. As in many other Japanese gardens, the ponds and islands of Kenrokuen are inspired by Chinese legends of mountain islands on the sea that were the abode of Taoist immortal hermits. Thus, besides being admired for their beauty, the ponds and islands were also symbolic of prosperity, longevity and wisdom.

The very name 'Kenrokuen', meaning 'Garden of Six Qualities', is a reference to an eleventh-century Chinese text, which stated that a perfect garden was difficult to achieve because it required the combining of six features grouped in mutually exclusive pairs: spaciousness and seclusion, air of antiquity and human artifice, water features and panoramas. In Kenrokuen, however, the spaciousness of open, light areas exists side by side with secluded walkways, interweaving a sense of immensity and intimacy. The ideas of antiquity and human artifice are represented in the placement of the weathered rocks, in the carefully tended moss cover on the ground, tree roots, lanterns and stones, and in the artfully trained tree branches designed to convey an impression of the workings of time. Water is abundant in Kenrokuen's

ponds, fountains and meandering streams, while at the same time the garden affords panoramas of the mountains to the south, the hills across the Asano River to the east, and the distant Noto Peninsula extending far into the Sea of Japan to the north.

Another instance of how cultural values inform landscape design in Kenrokuen is the attention given to the passage of seasons. The various natural elements composing this landscape are combined in such a way as to give full expression to the ideal beauty of each season, reminding of the use of prescribed seasonal topics in classical Japanese poetry. In winter, the garden exalts the spellbinding stillness and purity of snow. Spring envelops Kenrokuen in hazy clouds of cherry blossoms. In early summer, irises fill the waterways with hues of purple, and a fresh tapestry of velvety moss softens the contours with its rich greens during the rainy season. As autumn progresses, the array of dark green foliage starts turning branch after branch into flaming scarlet, glowing orange and radiant gold.

Urban green spaces and their ecosystem benefits

Continuous engagement of humans in nature is required to maintain the aesthetic and cultural values of the landscape in Kenrokuen. The appearance of spontaneity is achieved through sustained human effort. Each tree and patch of moss receives meticulous attention to ensure that the garden's natural beauty is maintained . In early spring, the first buds of the pine trees are carefully hand-picked in order to control the shape of the trees and encourage a second flush of green growth.

Every morning, women with their heads bound in scarves and covered with conical straw hats clean the leaves and twigs that have fallen overnight onto the moist carpet of moss. Then in November, as the year starts slowly falling into winter, gardeners again climb the large poles erected for *yukitsuri* to toss down coils of rope that will be attached to the branches, bringing the annual cycle to both an end and a new beginning.

A human-designed landscape meant to offer a feast of both the senses and the spirit, Kenrokuen is very different from more natural local landscapes. Yet with over 180 species of plants and its diverse pattern of land and water features, it is rich in species and microenvironments. The garden attracts numerous birds and insects, as well as some small animals, which travel along the green corridors leading from the forested hinterland along the river terraces and into the heart of the city. A wide variety of mushrooms sprout on the ground and tree trunks.

Kenrokuen shows how a biodiverse urban space can provide a variety of ecosystem services—the benefits that people obtain from ecosystems. Of these, the most obvious are the cultural services, which include a sense of cultural identity, heritage values, aesthetic pleasure, spiritual services, inspiration for literature and other arts, and recreation. The garden is also a powerful illustration of the economic relevance of cultural ecosystem services. As Kanazawa's major tourist attraction, Kenrokuen receives nearly two million visitors every year, making an important contribution to both the local and regional economy.

Kenrokuen is also a provider of lesser known regulating ecosystem services that are often taken for granted. The layered vegetation provides much needed shade in hot weather and helps reduce the heat island effect together with the water surfaces. It creates a barrier to noise and wind, and improves air quality by filtering pollutants. The soft ground surfaces allow rainwater to seep through, reducing flood risk and replenishing precious groundwater reserves. All these processes are underpinned by supporting services such as soil creation, carbon absorption or habitat provision, which also relate to human wellbeing. As part of a larger landscape, Kenrokuen is also a source of provisioning ecosystem services, with underground water from the surrounding mountains springing out on its grounds.

In winter, the carpet of snow obliterates colours and boundaries in Kenrokuen. And yet, in the uniqueness of each arrangement of straw ropes embracing the white sculptural shapes of the trees, in the unexpected rhythms of the landscape, there is a sense of nature and culture being infinitely diverse.

Paper umbrellas of Kanazawa: Interaction between humans and their environment

As snow turns into rain and then rain back again to snow, on Kanazawa's streets dark figures below umbrellas hurry to their destinations in ones and twos. The world has shrunk. Thunder clouds hang low in shades of charcoal. The wind carries the rain sideways. The fragile-looking umbrellas under which people huddle seem the only patches of colour in the liquefying gray cityscape.

Given Kanazawa's wet climate, umbrellas have long been an essential feature of daily life in the city. Today, umbrellas are made from nylon or see-through vinyl. But for hundreds of years before the advent of modern Western-style umbrellas, traditional Japanese umbrellas were made from oil paper and bamboo. Extant documents depict scenes from the past in which paper umbrellas made their appearance: large decorative umbrellas being carried in the clan lord's procession as he travels to Edo with his retinue of 2,500 attendants, to fulfill his obligation of residing in the capital in alternate years under the 'alternate attendance' system; a samurai's daughters setting out to visit the local shrine, their slender umbrellas against the dull, snowy sky; at the market, the varied sights of a jostling crowd of forms and faces, half concealed by umbrellas and bamboo hats; itinerant monks with dark robes and coarse brown umbrellas known as *bangasa*; a young man in a stylish kimono crossing the bridge in the morning snow storm, sheltering himself under a borrowed half-open umbrella on which the name of a tea house is inscribed in large characters.

Such snapshots tell us of how the climate and natural environment of a place influence material culture and lifestyles. Kanazawa's paper umbrellas were produced in response to the climatic conditions, relying on natural materials, most of them harvested from around the city. Timber bamboo *madake* and the larger variety known as *moso* bamboo were used for the wooden frames, which were covered with thick paper made from the wood of the *kozo* tree and glued onto the frame with a paste obtained from fern-root starch. The umbrella would then be waterproofed by treating the paper with persimmon tannin and applying green shiso oil, paulownia oil or linseed oil.

Over 100 umbrella stores dedicated to manufacturing paper umbrellas are said to have been operating in Kanazawa during the Meiji (1868-1912) and Taisho (1912-1926) periods. To meet the high demand, the workers specialized in a certain stage of the production process. In one place they would be busily engaged in splitting, trimming and curving the bamboo ribs. In another they would be cutting the paper,

gluing it onto the wooden frame or oiling the umbrellas. Today, traditional paper umbrellas are no longer a part of daily life. As a result of rapid post-war changes in Japanese lifestyles, they have been displaced by cheaper and more readily-available Western umbrellas. Only one artisan, Hiroshi Matsuda, still carries on the ancient craft of umbrella making in Kanazawa. Today's paper umbrellas are aesthetic objects, sought as accessories for traditional theatre or dance performances, or doubling as advertisements and decorative objects at Japanese inns and restaurants.

When a paper umbrella is closed, most of its surface is folded inward and hidden from sight. As it is opened, a work of art is slowly discovered. The space takes on a different light and depth under the paper hand-painted with flowers, insects or abstract patterns. The natural materials give a feeling of warmth and aliveness. With its robust, full design, its four layers of lacquered paper applied to the centre, and its intricate web of colourful strings attaching the frame to the base, the Kanazawa paper umbrella is a reminder of the harsh climate it was created to withstand. The artisan's labour of love and his endeavour to combine beauty with durability is apparent in every single detail, inspiring a sense of respect and care.

Endlessly perfected in the interaction between people and their environment, the paper umbrella has been elevated to a work of art. It enhances the beauty of the dancer's silhouette as he poses on stage, holding his umbrella overhead and looking off at the imaginary mountains in the distance.

SPRING

The ecosystems around Kanazawa's urban area have played an important role in giving shape to the physical form of the city in terms of its functionality and aesthetics, and in sustaining its lifestyles. The city's rise as a flourishing cultural centre was made possible by the diversity of the surrounding ecosystems—from forests to freshwater, to plains and marine environments—which provided it with an abundance of resources and services. As the city's space was being molded in response to climatic factors, and based on local socio-cultural categories, specific resource uses and practices for managing the biodiversity of these surrounding ecosystems emerged.

The bamboo poles used to brace tree branches against winter snows in Kenrokuen, the plant materials necessary for paper umbrella manufacturing and the wood for the city's buildings have all traditionally come from the forests covering the mountains around Kanazawa. Management systems were developed to ensure the continuous provision of goods, services, food and livelihoods from these forests, resulting in human-influenced landscapes that maintained and adapted the region's local bio-diversity. In spring, as the warm winds slowly bring Kanazawa's forests out of their winter slumber, the vitality and diversity of forest life, nurtured by centuries of human management, is powerfully manifest. Although originally managed for their productive functions, these forests are also sites of aesthetic enjoyment, and the exuberant renewal of life in spring attracts visitors eager to experience the scenic beauty of nature. The delicate colours of nature in spring have been a major source of inspiration for local *Kaga yuzen* silk-dyeing artists, who pay particular attention to the transitions marking the passage of the seasons.

Satoyama: A mosaic of ecosystems on the urban fringe

Spring arrives later in Kanazawa's surrounding hills than in the city. By the time the cherry blossoms are starting to bloom in Kenrokuen, patches of snow still linger in the *konara* oak forests and rice paddies, overhung with sprays of plum blossoms. Brimming with the melted snows of winter, the chilly surfaces of the irrigation ponds are smooth and clear.

The forests around Kanazawa are part of what is known in Japan as a *satoyama* landscape, a mosaic of different ecosystem types—secondary forests, farm lands, irrigation ponds and grasslands—along with human settlements, which has been managed to produce various ecosystem services for human wellbeing. These landscapes emerged and developed through prolonged interaction between humans and ecosystems and are most often found in rural and peri-urban areas of Japan. *Satoyama* forests around the cities have traditionally supported urban communities with a variety of raw resources, including wood, fuel, fibre and food. For centuries, the demand for wood construction materials in Kanazawa was met by timber harvested from the peri-urban forests, which was used for the building and rebuilding of castle structures, temples, shrines, houses and bridges. Traditional local architecture made diversified use of the various types of wood available, from the strong, durable wood of the *ate* tree used for the foundations of the houses,

to cedar for pillars, pine wood for the roof beams, and beautifully grained *keyaki* wood for the massive central pillar of the house, which supported the roof while being an important decorative element of the architectural structure. In addition to construction timber, the *satoyama* forests around Kanazawa also played a vital role in supplying city dwellers with charcoal and wood fuel prior to the shift to fossil fuels in the 1950s. Periodical thinning and cutting of the trees resulted in well-maintained, sunlit secondary forests with diverse tree varieties that have provided a variety of other plant resources. These include plants used as food, such as bamboo shoots, wild mushrooms and log-cultivated shiitake mushrooms. Edible wild forest plants are still popular among Kanazawa's residents, who walk the forests in spring to gather light green-tinted butterbur stalks (*fuki no to*), flowering fern sprouts (*zenmai*), brackenroot (*warabi*), fatsia buds (*tara no me*) and celery-like Japanese spikenard stalks (*udo*). Before the advent of modern medicine, the forest also provided medicinal plants, with dewdrop crane's bill (*gen no shoko*) being used as a remedy for intestinal problems, mugwort (*yomogi*) as a coagulant, and fish mint (*dokudami*) to eliminate toxins from the body.

Over the last half century, the socio-economic production landscapes of *satoyama* have seen a rapid decline, brought about by the cumulative impacts of urbanization, modernization and industrialization. Two opposing trends have affected Kanazawa's *satoyama*. On the one hand, a physical loss of woodland area has occurred as forests were converted into residential districts and industrial parks. On the other hand, today's *satoyama* forests are also faced with problems arising from under-use and under-management, as a result of changes in the fuel and construction needs of urban residents, combined with an increasingly displaced ecological footprint of cities and with the depopulation and ageing of rural communities. In some areas, the broad-leaf forests of *satoyama* have been converted to fast-growing coniferous monocultures.

The degradation of *satoyama* has a negative impact on the species inhabiting the brighter and more open environment characteristic of managed forests, as well as on the ecosystem services they provide. Endangered butterflies such as the *gifucho* swallowtail, which rely on the existence of managed mixed woodlands for their survival, are symbolic of the decline of *satoyama*. When formerly managed forests are abandoned, they soon become overgrown with an impenetrable tangle. Unpicked bamboo sprouts shoot upward fast during the rainy season, and bamboo establishes itself in the forest, blocking most of the light. A closed canopy that does not permit sunlight to reach the forest floor will not allow the same level of plant and animal biodiversity as a *satoyama* forest. An overgrown forest may also be less

capable of providing essential services such as soil formation, erosion control, water retention, watershed protection or carbon sequestration.

In Kanazawa, various initiatives by the city government, local universities and civil society groups are now underway in an effort to reverse the trend of forest under-use and preserve the rich ecosystems of *satoyama* landscapes. These initiatives share an endeavour to reconnect people with the landscape and teach them how to take care of it. *Satoyama*'s fields and forests are being promoted as sites of learning and play, where urban residents can immerse themselves in nature while acquiring an appreciation of the wild flora and fauna it shelters. Local volunteers monitor species, learn how to cut bamboo, reconstruct rice paddies and clear irrigation canals. Some of the activities focus on the experience of the social and cultural values of *satoyama*, encouraging participants to create traditional artifacts using *satoyama* materials or to take part in *satoyama*-related annual celebrations. The local government is also exploring policy measures for linking the cultivation and harvesting of specific tree species with Kanazawa's craft industries.

As the snow finally vanishes in April, visitors join tours to the *satoyama* area of Hiraguri, one of Kanazawa's designated Natural Environment Protection Areas. The tours highlight the richness of life that has flourished in the *satoyama* landscapes transformed and maintained through traditional rural lifestyles.

Kaga yuzen silk-dyeing: Biodiversity and artistic inspiration

A newly finished kimono is draped on a stand in the *Kaga yuzen* silk dyeing artist's studio. The silk shape has been diagonally divided into two areas, one sand-coloured and the other a soft, demure gray. Against this background are painted cascades of plum twigs with red and white blossoms, hanging from above. Right under the tips of the twigs, at the bottom of the kimono, stylized, gently curving ripples suggest that we are looking at a river or pond from amidst the blossoming branches of plum trees.

A closer look at the blossoms reveals buds tinged with red, others that have just started to spread out their petals, dark stems connecting the buds to the twigs, finely dotted stamina and subtle colour shadings within the blossoms, and even small patches of pink lichen on the branches.

In Japanese literature and painting, the image of plum blossoms is a symbol of the beginning of spring *shoshun*, which corresponds to the period between the first two of the twenty-four seasonal turning points of the lunar calendar used until the

adoption of the Western solar calendar in 1872. As the divisions of the lunar calendar show, seasons are not homogeneous stretches of time, but dynamic periods of diversity and transformation. Spring itself has many faces. It starts at the coldest time of the year in February with the 'rise of spring' (*risshun*), soon after which the plum blossoms begin blooming, and then progresses through 'rain water' (*usui*), when the snow gives way to rain, the 'awakening of insects' (*keichitsu*), when the insects come out of hibernation and the first herbs begin to sprout, the 'spring equinox' (*shunbun*), 'clear and bright weather' (*seimei*), which is the time of the cherry blossoms, and 'grains rain' (*kokuu*), a fifteen-day season when planting begins.

Kaga yuzen designs capture the diversity of nature in spring through a multitude of vegetal motifs: plum, peach or cherry blossoms, magnolias, furry willow catkins, rape blossoms, red and white flowering dogwood, purple China asters, white deutzia flowers, and noble orchids, to name but a few. Familiarity with the symbolism of the seasons deepens the appreciation of the patterns.

Yuzen dyeing, which was first developed in Kyoto around the end of the seventeenth century by craftsman Yuzensai Miyazaki, involves hand-dyeing fabrics to create patterns, as opposed to the woven fabrics using previously dyed silk thread, which had been traditionally used for the garments of the aristocratic class. Later in life, Miyazaki moved to Kaga, where he played an important role in integrating the new technique with the local dyeing method known as *Kaga okunizome*. Thus, two closely related traditions of *yuzen* silk-dyeing came into being: *Kyo yuzen* in Kyoto, which uses more stylized, bolder motifs in vivid colours, as well as metal leaf and embroidery, and *Kaga yuzen* in the Kaga Province, distinguished by its deeper, more subtle tones, exclusive reliance on dyeing, and nature-inspired themes such as plants and birds.

Kaga yuzen artists devote a great deal of attention to the study of the forms, lines and colours of nature, which they record in their sketchbooks. Some of the frequently employed techniques have the effect of adding realistic touches to the designs. These include gradating colours to suggest volume and an interplay of light and shade in leaves and flower petals (*bokashi*), using glue to cover the outline of the design and prevent dyes from spreading, which leaves white lines between the elements and enhances details such as leaf veins (*itomenori*), and depicting insect bites on the leaves (*mushikui*).

But the inspirational influence of nature on *Kaga yuzen* is not limited to the designs. The natural pigments that were originally used to create its polychromatic visual universe have also left their distinctive imprint on the craft. The silk-dyeing tradition of Kaga, which was later fused with *yuzen* techniques to create *Kaga yuzen*, used plum bark and persimmon tannin to produce hues ranging from pale peach to various shades of red and brown. One of the innovations of *Kaga yuzen* was the

introduction of five additional natural pigments: dark crimson, indigo, yellow ocher, grass green and ancient purple. Although chemical dyes have today replaced natural ones, these colours continue to represent the basis of *Kaga yuzen* silk-dyeing, which retains something of the soft, intricate shades of natural pigments.

The diversity of the city's nature has been a storehouse of knowledge and inspiration for *Kaga yuzen* artists, who have been moved by the beauty of individual organisms, landscapes and natural processes, and have perfected ways of reproducing them on silk as designs that turn kimonos into family heirlooms. In *Kaga yuzen* the boundary between art and craft is ambiguous, with considerable creativity being deployed to create an object that combines aesthetic and utilitarian functions. Kimonos are still a relatively common sight in the daily cityscape of Kanazawa. Now and then, you can spot a woman pass by with a sweeping flourish of kimono sleeves, or a man in a somber-coloured kimono walking under the budding trees of spring.

SUMMER

Food production and consumption comprise a major dimension of human life in which biological and cultural diversity intersect and are mutually reinforcing. The influence of biodiversity on Kanazawa's food culture spans all the scales on which biodiversity occurs, from landscapes to local crop varieties. The city's vibrant local cuisine displays creative combinations of ingredients and tastes, reflecting the diversity of the plentiful supply of fresh foods provided by the surrounding sea, fields and mountains. Local food culture, as manifested in the tastes and desires of the city's people, has played an important role in the continuous cultivation and use of traditional vegetables, selected over the years for desired characteristics, as they were taking into themselves the very substance of the region's soil and climate.

Many of these traditional vegetables reach maturity during summer, which in Kanazawa is a season of intense sunlight and heat, slowing down the rhythms of the city. Gastronomy is an important part of the colourful festivities bringing people together on summer nights, after the relentless heat has subsided. Some of these festivities focus specifically on agricultural production, and belong to a complex annual ceremonial cycle rooted in culture-specific views of nature.

A different interplay of biological and cultural diversity can be observed in the case of recreational river fishing practised in Kanazawa in summer. Summer fishing for sweetfish (*ayu*) in Kanazawa's rivers shows how recreational practices, cultural heritage values and a sense of beauty can converge in food production activities.

Kaga vegetables: Agricultural biodiversity and cultural identity

In July, as the summer heat slowly approaches its height, white buds burst into bloom among giant leaves of green jade in Kanazawa's lotus fields. Lotus has a long history in the city. During the Edo period, it was grown in the ponds of Kanazawa Castle for its ornamental flowers, and high-ranking samurai also consumed it as medicine. Several lotus varieties cultivated for their edible rhizomes were introduced to the area in the nineteenth and twentieth centuries. Of these, a locally selected variety, distinguished by the crunchy texture of its fibrous roots, continues to enjoy popularity as one of the city's praised Kaga vegetables. In summer, its immaculate white blossoms greet visitors to Kanazawa as they arrive into the city from the east.

Fifteen of the traditional vegetables produced in Kanazawa since before 1945 have been designated as Kaga vegetables, a local brand established by Kanazawa City and the Agricultural Cooperative. Kaga vegetables feature prominently in the local produce corners of the city's markets and food stores, reminding customers of the relationship between local vegetable varieties, food and the city's cultural identity.

In recent years, various reasons have been invoked in global discussions for the need to safeguard the biodiversity of cultivated species by conserving and utilizing traditional varieties that are increasingly threatened by the widespread introduction of modern breeds. Traditional varieties have been shaped by farmers' seed choices, while adapting to specific environments over generations of cultivation.

With their different abilities to withstand a range of environmental conditions, traditional varieties are a reservoir of options for the future, allowing human societies to switch to a different existing variety or to develop new ones when environmental change occurs. Not only can they contribute to better nutrition, income generation and environmental conservation, but they also hold important cultural values, being embedded in local cuisine, customs, lifestyles and social relations.

Cultural values played an important role in saving Kanazawa's traditional vegetables from vanishing in the sands of time. The onset of Japan's period of high economic growth in the 1950s marked the transition to modern hybrid crops bred for higher yields, uniform shapes and disease resistance. Kanazawa's patrimony of local vegetable varieties was in danger of being lost in the competition with the more productive, standardized, placeless vegetables promoted by industrialized agriculture.

The driving force behind the movement for conserving the city's traditional vegetables was Ryo Matsushita, the fifth-generation owner of a seed-and-plant store. Since 1861, when the store opened on the Hokkoku Kaido highway, which ran along the Sea of Japan and connected the northern provinces with Kyoto and the Ise Shrines in the south, the seed merchants of the Matsushita family partook in a tradition of exchange of information and seeds. A convenient stopping place for travelers, the store served as the gateway through which seeds from all over the country would enter Kanazawa to be selected and adapted according to local conditions. Faithful to his family's past, Matsushita started collecting seeds and in 1991 formed the Association for the Conservation of Kaga vegetables, which encourages farmers to save, share and cultivate traditional vegetable seeds.

The Association played an important role in the establishment of the Kaga vegetables certification system. Of the thirty-two traditional vegetables identified in the city, the fifteen designated so far are those for which existing production was deemed sufficiently robust to render them economically viable. Efforts have been made to raise the profile of Kaga vegetables, marketing them both locally and nationwide, disseminating information on their history and characteristics through websites, and developing specific cooking recipes to stimulate demand.

Unlike new breeds that can be found in supermarkets all year round, Kaga vegetables follow the natural rhythms of the year. The excitement of the seasons is enhanced as colourful vegetables slowly ripen in the fields. Summer is the harvest season for six of the Kaga vegetables, and market stalls are piled high with the greens and purples of *kinjiso* and *akazuiki* leaves, the bright red of chestnut-flavoured Utsugi pumpkin, plump and glossy violet-stem eggplant, the delicate greens of young Kaga hyacinth beans and the earthen shades of lotus root. As the cool of autumn settles in, these are replaced by red-skinned Gorojima sweet potatoes, white *gensuke daikon* radish and Kanazawa thick leek, and the smooth beige of *kuwai* arrowhead bulbs. Winter is the season of long, slender and soft Japanese parsley, while the verdant flush of leaf mustard, garland chrysanthemum leaves and Kaga thick cucumbers, along with chunky and pale bamboo shoots, announce the arrival of spring.

Kaga vegetables are also closely connected with the features of the city's landscape, to the different soils, climates and landforms. Leek and eggplant thrive in the volcanic ash soil of the hills in the south-east of the city, left behind by past eruptions of Mount Haku. Sweet potato fields extend on the sand dunes along the coast. *Kinjiso* leaves grow along the foot of the mountains, where they absorb moisture from the spring mists and deepen their colour as temperatures vary between day and night. Lotus root and arrowhead prefer the low-lying marshy fields in the north-east. Given their adaptation to natural soil conditions, traditional vegetable cultivation relies on less chemical inputs, contributing to soil conservation.

One of the reasons traditional Kaga vegetables are threatened is that they require far more work to cultivate and harvest than new breeds. Arrowhead, for example, grows in flooded fields with a deep layer of clay-like soil. Kaga thick leek is particularly brittle and vulnerable to strong winds. Despite these difficulties, farmers in Kanazawa are willing to carry on cultivating the local varieties that have been central to the city's culinary traditions.

Relationships between traditional vegetable varieties and local food culture have a cultural side that goes beyond preferences for certain aesthetics of taste. Kaga vegetables play an important role in the famed local Kaga cuisine. Conjuring up images of the opulent culture of the lords of the Kaga domain and of exclusive Japanese-style restaurants, Kaga cuisine is in reality a recent term introduced to promote Kanazawa's traditional home cooking, which features signature dishes such as duck meat stew and steamed sea bream.

Kaga cuisine emphasizes not only the food, but also the experience of the entire context of the meal. Restaurants specializing in Kaga cuisine retain something from the atmosphere of old Japan, with wooden architecture and scenic garden views. The choice of ingredients, tableware and garden designs is in harmony with the seasonal shifts in climate and the changing faces of nature. In the endeavour to capture the sights and aromas of the seasons, Kaga vegetables are indispensable. The Kanazawa lacquer-ware, with its lavish decoration of gold and silver motifs, and the colourful Kutani porcelain on which the food is presented, also have a seasonal theme. Encompassing all these elements, Kaga cuisine is a carefully staged performance, reflecting both the diversity of its environs and the cultural influences that have ebbed and flowed throughout history.

There are many factors behind the continued presence of the colours of Kaga vegetables on Kanazawa's fields, market stalls and tables: a nostalgic attachment to the tastes of the past, the touristic lure of culinary specialties, the food mileage movement, and a successful branding strategy, to list but a few. They all show that cultural values of food can contribute to valourizing and conserving local varieties of cultivated species and biodiversity at large. The future of our food systems might depend on our creativity in unveiling the roles of biodiversity in what we cherish about our communities and places, and in incorporating them into meaningful experiences.

Seasonal celebrations of nature and culture

On hot midsummer nights, the thick air is rich with the scents of the fields, flickering torches and the sound of drums. It is the time when *mushi okuri* rites are held to chase away pests and protect harvests in the agricultural communities on the fringes of Kanazawa City. During the day, groups of children and youngsters parade along the streets, carrying white banners inscribed with wishes for plentiful harvests, protection from harmful insects, prosperity and peace. As dark descends, adult members of the community join in a procession with drums and torches along the footpaths between the rice paddies as they chant: "Abundance of the five grains! We are sending rice pests away!". The powerful sounds of the drums reverberating through the night are meant to dispel the evil spirits whose workings were considered the cause of pest outbreaks. A roaring bonfire, set ablaze towards the end of the ceremony, dances against the night sky.

Mushi okuri rites are one of the many annual celebrations that mark the rhythms of the seasons in Kanazawa. Although today the widespread use of pesticides has eliminated the threat that a sudden insect outbreak could totally ruin the harvest, causing the decline of *mushi okuri* rites throughout Japan, the practice is still observed in some of Kanazawa's communities after the midsummer weeding of the rice fields, when the insects are most abundant. *Mushi okuri* is associated with the growing season, the middle period of the agricultural cycle in which many of the calendrical festivities of the farming communities in Kanazawa's peri-urban area are grounded.

In spring, at the time of planting, local Shinto shrines become the stage for community festivals meant to ensure abundant crops later in the year. Autumn festivals are held before and after the harvest as an expression of gratitude. As occurs elsewhere in Japan, such festivals involve summoning the tutelary deity of the land, often a nature or ancestral deity that controls the fertility of the fields and natural calamities. The deity is paraded through the streets in a palanquin and entertained with food, drink and performances in order to enhance its power and secure its favourable intercession.

The annual calendar brings together a variety of seasonal festivities based on different spiritual traditions into a single temporal sequence. While agricultural festivals related to planting or the harvest are associated with the natural polytheism of Shinto, summer is the season of the most important Buddhist festival of the year: the Obon Festival, which honours the spirits of departed relatives and ancestors. At this time of the year, ancestral spirits are said to return to this world to visit their homes. It is holiday season in Japan, and people return to their hometowns to spend time with their families and look after the ancestral graves. Houses are cleaned, altars decorated and lanterns lit to guide the spirits on their way home. Offerings of food and flowers are made at the family Buddhist altar and sutras are chanted. Stands for drummers are set up in temple yards and other open public spaces, ringed by circles of people performing Obon dances to welcome the ancestors.

In the central areas of Kanazawa, the Obon Festival is celebrated in mid-July, while in the peripheral rural areas, which have been incorporated into the city's administrative area over the last century, the date continues to be determined based on the lunar calendar, corresponding to mid-August. According to local custom, small rectangular paper lanterns known as *kiriko* are lit at the graves to guide the souls on Obon nights. As the hills of Utatsuyama and Nodayama come alive with the soft glow of the *kiriko* lanterns, the city is filled with the music of Obon dances floating in the air and the swish of summer kimonos. Summer is a time of sensuous encounters between nature and performance, which shape the cultural landscape of the city.

Annual celebrations are reflective of broad worldviews, of concepts of the cosmic order and the human place in it, arising from present and past spiritual traditions and systems of belief. Such worldviews and concepts evolve within the specific ecologies of each community's natural environment. They reflect back upon the environment through our spiritual connections to the natural settings that we value as sites of ritual, ancestral worship and communal celebration.

Kaga fishing flies: Kanazawa's rivers and recreational practices

On a clear summer morning, in one of the green bends that the Asano River forms at the foot of a hill, an angler wades through the water with a fishing rod, trying his luck for the *ayu* sweetfish that leap occasionally into the air with a silver gleam. He whips his line in a smooth arc and the colourful fly cuts through the air, dropping like a real insect on the water under the willows.

The manufacturing of artificial flies for *ayu* fishing has a long tradition in Kanazawa. The store that produces and sells the Kaga fishing flies near the Omicho Market boasts a history of nineteen generations of merchants since its establishment in 1575. A visit to the store reveals an impressive array of lures resembling exotic, brightly-hued insects, with their hooks wrapped in colourful threads and decorated with bird feathers.

The flies are crafted based on the careful observation of various factors: from the behaviour of fish and the stage of their growth, to weather, time of day, location, temperature and depth of the water. Over the centuries, the store has developed an estimated 4,000 distinct fly types, suited to each combination of natural conditions. In their varying colours and forms, the flies encode and transmit a rich knowledge of nature, including the preferences of the *ayu*, but also changes over time in the water quality, transparency and temperature of the river environment.

An important role in the development of the Kaga fishing flies has been ascribed to the samurai of the Kaga domain. According to local lore, *ayu* fishing was recommended to members of the warrior class for its spiritual and health value, as training for the body and the mind during the peaceful times of the Edo period. Bringing in the fish with the barbless Kaga flies required concentration and a good

sense of timing. The samurai became absorbed in their pastime, perfecting the flies and thus paving the way for the development of what remains today one of Kanazawa's rare traditional crafts.

Kanazawa's rivers have influenced the city's cultural history, including its recreational practices. A nineteenth century folding screen depicting scenes from the Sai River shows people with woven sedge hats fishing for *ayu*, and groups eating lunch boxes on the river banks. The figures represent clansmen and their families, since such forms of river entertainment were prohibited to commoners under the rule of the Kaga clan.

With the abolition of the clan system in 1868, Kanazawa's rivers became accessible to everyone, and bathing, fishing and feasting on freshly caught *ayu* and *gori* fish by the river's side became common summer sights. Old photographs from the beginning of the twentieth century show the Asano River filled with people bathing. Enjoying the relative coolness of summer nights on the river in pleasure boats hung with lanterns seems to have also been a popular entertainment form.

Many rivers in Japan's larger cities are today encased in concrete and roofed over by highways, but Kanazawa's rivers remain enchantingly alive. From the bridges spanning the Asano and Sai Rivers, one can spot the dark shadows of the fish swimming in the current. Small flocks of ducks glide lazily on the water surface. With ritual-like, elegant movements, solitary white egrets and great blue herons step through the shallows. Dragonflies hover motionless over the tall grasses.

Seeing people get into the river for one reason or another is not unusual in Kanazawa. Even on winter mornings, some *Kaga yuzen* dyers would start rinsing swaths of colourful silk cloth in the Asano River to remove paste and excess dye, but this scene is becoming increasingly rare today. It is during the stifling summer heat, that the rivers entice most with their irresistible lure. Groups of children walk into the river with their teachers to learn about water organisms. Men pile stones together on the riverbed to guide the flow that will carry the floating lanterns during summer festivals. Couples sit on rocks with their bare feet in the water, the breeze ruffling their hair. *Ayu* fishers still cast their rainbow-coloured flies through the air with crisp, sword-like movements.

For centuries, the multifunctional landscapes of Kanazawa's rivers have provided food and space for recreation. Today, they continue to be oases of beauty and abundance in the cityscape, where people can immerse themselves in the natural settings, experience their sounds and sensations, and enjoy life.

AUTUMN

As the cool of autumn starts to descend over the city, the tops of Mount Haku and of the other mountains in the Kaetsu Range lining the horizon are luminous with the first scattering of snow. The crimson and rust tints of autumn have crept over the wooded hills hemming the city. Everywhere there are sights and sounds of rippling water from the autumn rains that have returned to Kanazawa.

Spreading over two major rivers, Kanazawa is a city blessed with abundant water resources. Precipitation is stored in the roots, fallen leaves, moss and decaying wood of the headwater forests in the mountains, sinking through the soil to the underground sources of springs. Water reappears as streams and rivers, flowing through downstream fruit orchards, vegetable fields and rice paddies, and then through the city to the wetlands of the Kahoku Lagoon and into the sea. There is no wonder that Mount Haku, one of Japan's three sacred mountains and the source of four large rivers—the Tedori, Kuzuryu, Nagara and Sho—has long been worshipped as a deity of water.

Various traditional industries rely on the water resources of the region, from paper, gold leaf manufacturing and silk dyeing, to sake and soy sauce production. The arrival of autumn marks the start of many of the processes associated with these industries, as it is during the cold months of the year that water is clear. Biodiversity has supported Kanazawa's traditional industries at all levels: through the water-regulating function of the forests, through the direct provision of plant materials, and through the workings of the microscopic diversity of organisms involved in the processes of fermentation central to much of the local food culture. At the same time, water has been a mainstay feature of the cityscape, with an intricate network of waterways providing habitats for plants, fish, birds and insects, while adding to the aesthetic value of the city.

Futamata paper-making: Water and traditional industries

The pure, cold running water of the late autumn and winter months has been essential to Japanese paper manufacturers in the Futamata area at the foot of Mount Iozen, who were once the direct purveyors of paper to the Kaga clan. A linear village surrounded on three sides by mountains, Futamata was built at the juncture of two watercourses that merge to form the Morimoto River.

Japanese paper requires large amounts of water in all the stages of the manufacturing process. The branches of the plants used to produce the paper are first steamed to strip the bark, which is then steeped in water to remove the outer layer of black skin. The inner white bark is washed, soaked in running water and boiled. Once the fibres are softened and easily separated, they are mixed with water and a viscous substance made from the roots of the *tororo-aoi* plant, and beaten together with a wooden frame lined with a fine bamboo mat, so as to spread them evenly on the mat. The frame is then raised and the liquid drained, leaving a sheet of paper resting on top.

After the Meiji Restoration of 1868, traditional paper-making in Futamata lost its former protectors and suffered from a decline in demand as machine-made Western paper took over. Listening to one of Futamata's remaining three paper artisans, Hiroshi Saito, as he shakes the wooden frame back and forth inside the water with a rhythmical movement brings to mind the mesmerizing symphony of water sounds that must have filled the village in the past.

Japanese paper-making is tied with the natural rhythms of the seasons. It starts at the end of the year, when the rice harvest has ended, and relies on resources available in the colder months. Not only does paper production require cold flowing water, but much of the management of the plant resources also takes place during the autumn and winter seasons. The main materials used in Japanese paper-making are *kozo* paper mulberry, *mitsumata,* a cultivated shrub with nodding clusters of scented yellow flowers, and *ganpi*, a rarer species that only grows in the wild. The twigs are harvested in late autumn after the leaves have fallen, when papermakers also divide the old roots of their paper mulberries, replanting them to start a regeneration process that will take five years of repeated cutting of the stalks before a dense shrub ready for use is obtained. It is also in autumn that the *tororo-aoi* plant from the nearby forests is at its prime, resulting in superior, more durable paper.

The tree species used in paper manufacturing are said to be strongly influenced by the local specificity of their environment. The unique character of the paper created in each area is therefore the product of a mysterious combination of water, soil and climate with the choices made by the artisan in pursuit of the highest quality. During the Edo period, Futamata supplied the Kaga rulers with a variety of paper types, from smooth, thick paper for formal public documents, to softer paper for ceremonial letter writing, brush calligraphy and woodblock prints, furrowed paper for wrapping gifts and covering sliding doors and screens, and paper cores for gold and silver threads used to weave kimono fabrics.

Today, hand-made paper produced from natural fibres in Kanazawa continues to delight with its versatility and warm feel, and with its depth of texture that almost invites being illuminated from within to reveal the intertwining fibres. The continuing existence of Japanese paper is proof of its intimate connection with certain aspects of Japanese culture. When used as wrapping, the texture of the paper, its colours and the way it is folded in the wrapping process add to the attractiveness of a gift. In a country where the culture of letter writing is still alive, handmade paper is also the essential medium for important correspondence, which is beautifully written in ink calligraphy, uses prescribed courtesy formulas, and would almost always start with a reference to the season. The versatile paper, which can be molded into almost any shape and functionality, is also indispensable to other traditional crafts of Kanazawa: from extremely fine paper sheets which serve as support for gold leaf sheets a mere one thousandth of a millimetre thick, to strong, durable paper sewn in as linings to bags and purses accessorizing fancy kimonos.

Sake*:* Water, microorganism diversity and culture

At the start of the sake-making season in October, brewers in Kanazawa visit the Matsuo Shrine in the Utatsuyama Hills, a branch of a Kyoto shrine with the same name worshipping a deity of sake and water. A small wooden altar inside each brewery, decorated with sacred ropes and offertory strips of paper, is also dedicated to the sake god. Later in the season, when the pressing of new sake begins, large balls made of cedar leaves are hung under the eaves of breweries. As days pass, the green balls slowly turn brown, announcing that brewing is in progress. These cedar balls, known as 'sake forests' (*sakabayashi*), are traditionally provided by the Miwa Shrine in the Nara Prefecture, home to another sake deity associated with mountains, harvests, water and thunder. The character of the guardian gods of sake-making suggests the strong dependence of the beverage on water and on the presence of healthy, biodiverse forests.

Water is essential to each step in the manufacturing process of sake and makes up 80 per cent of the final product. Japan's historically important sake-brewing centres grew in rice-cultivating regions with an abundant supply of quality water. The distinct identity of local water also contributes to differences in sake flavour. In Kanazawa, sake is brewed with the clear water filtered through the layers of

ancient rock from Mount Haku, which is a relatively hard water, allowing for more vigorous fermentation.

The region around Mount Haku has a long-established tradition as a sake-making locale. As early as the sixteenth century, when regional sake varieties became popular, the Kaga Province was known for its 'chrysanthemum sake'. In Kanazawa, sake breweries lined the banks of the Sai River, which carried the crystal clear waters of melted snow from Mount Haku into the city. Brewery workers scooping water from the river were an integral part of the city's landscape in the cold months up until the first decades of the twentieth century.

Sake-brewing is a late autumn and winter activity, because at this time of the year water is at its purest and stable temperatures allow for the control of its influence on the other ingredients: rice, *koji* mold and yeast. In addition to the crucial importance of water to sake production, the first most significant factor is considered to be the *koji* mold, the second, the mixture in which the yeast develops, and the third, the technique used.

The character of Kanazawa's sake arises from the interplay between features of the natural environment, including water rich in minerals and a climate particularly suitable for fermentation, microorganism diversity, and the skillful management of their interactions by the head brewer, the *toji*. The way in which the life cycle of the *koji-kin* mold is managed and the choice of yeasts used in the fermentation process have a massive impact on the sake's characteristics. Sake cannot exist without the mold, which converts the rice starches into sugars producing *koji* rice, a sweet-flavoured rice with a white frosting on the grain. *Koji* is further mixed with steamed rice and water to create an environment for yeasts to work, feeding on sugars and producing alcohol and other substances.

The different combinations of chemical compounds that different yeasts produce from the same ingredients determine the fragrance of the beverage. While in the past distinct yeasts were closely associated with the identity of each brewery, in whose barrels they lived for centuries, in the Meiji era a national system was established for identifying, promoting and distributing superior yeasts to brewers.

The diversity of sake flavours reflects not only the diversity of environments, but also that of the interactions between brewers and their resources, which are informed by local preferences, production traditions and human intuition. The complex variety of taste found among Kanazawa's sakes is inscribed within the larger profile of sake in the region: a compact, dense flavour that has evolved towards a drier style over the last few decades. From fruity fragrances and smooth textures to full-body sake with a rich rice aroma and sharp finish, in the flavour palette of Kanazawa's sake you can taste the goodness of local water, the silent workings of microscopic life, human ingenuity and the diversity of their interactions.

Sake is also part of the city's larger web of social and cultural relations. The sake culture of Kanazawa lies in the extension of the culture of consumption and refined play that characterized the city during the prosperous rule of the Kaga clan. The samurai elites held drinking parties in the tea houses of Kenrokuen and under the cherry blossoms of the Utatsuyama Hills in spring. Wealthy merchants purchased fancy order-made sake cups from lacquer-ware craftsmen in Kanazawa, but also lacquer-ware with 'sunken gold' decorations from Wajima, a port town at the tip of the Noto Peninsula. The city had its share of drinking establishments for shop workers and farmers from the surrounding villages, which were distinguished by the short curtains made of braided rope at the entrance. Following the Meiji Restoration, a profusion of traditional and modern entertainment facilities emerged in Kanazawa, resulting in today's motley mix of sites for social drinking, from old-fashioned shops selling *oden* fishcake stew to modern bars, and from affordable chain pubs to high-end Japanese restaurants where clients are entertained by geisha.

Sake is diverse and the contexts in which it is consumed have also been diverse, changing with the trends of time, the physical setting or the relationships between the people partaking of it. The experience of sake drinking also has a seasonal dimension. Autumn is the season of *hiyaoroshi*, sake which were pressed the previous winter, pasteurized and then left to age in sealed tanks over the spring and summer, to be finally shipped without the usual second pasteurization when the outside temperature starts to lower. Autumn is also the time to enjoy seasonal seafood delicacies reputed

to go well with sake and enhance its flavours: globefish and globefish roe pickled in rice bran or sake lees, cod milt, sea cucumber roe, or, for a different taste, dried and salted gonads of sea cucumber, female crab innards, and a fermented sushi made with turnip and yellowtail. At the time when the new sake-brewing season starts, the Sea of Japan turns rough, lead-coloured and immensely fertile.

Canals: Infrastructure junctions of blue and green

If we take a seventeenth century map of Kanazawa and compare it to a current one, we realize how many characteristics of the historical structure of the old castle town have been passed on to present-day Kanazawa. Many of the yellow roads stretching around the vast castle grounds at the centre of the map can be superimposed over the asphalt roads of today. Where modern offices and shops stand now, the map shows residences of samurai and merchants. Temples and shrines that still dot the cityscape are located in the green hills on the east and south.

The map also captures the city's network of waterways, some of its elements easily identifiable, others long lost in the mists of time: the almost parallel rivers of the Asano and the Sai flowing on the two sides of the plateau where the castle is located, the geometrically shaped moats around the castle, two further concentric defensive lines consisting of an embankment and an outer moat, and an extensive web of canals, spreading like blue veins from the rivers throughout the city.

Kanazawa's canals have played a vital role in the development of the physical shape of the city, but also in its economic, social and cultural life. The Oonosho Canal, which flows today along the tile-roofed ochre walls of the former samurai district, was built at the end of the sixteenth century to transport timber for the construction of Kanazawa Castle and the town that developed around it. A few decades later, construction work started for the Tatsumi Canal, which was designed to bring water into the castle, fill its moats and serve for fire prevention. A remarkable feat of civil

engineering given the castle's elevated position, the canal featured a five kilometre tunnel piercing the terrace cliffs of the Sai River—now a designated National Historical Site—and an inverted siphon supplying the castle with water. These and numerous other canals also provided water for irrigating downstream fields, served domestic uses and powered the rapeseed oil manufacturers of the Edo-period Kanazawa, as well as the silk mills that restored vitality to the city's economy after the Meiji Restoration. At the turn of the twentieth century, Kanazawa's first power generating station and public water supply system used water from the Terazu Canal.

As the city modernized, Kanazawa's canals seemed to have been left behind. During the post-war period, pollution problems became increasingly severe as the canals acted as sewers for the direct discharge of wastewater and dumping places of garbage. The conduits were covered to provide parking spaces for cars, and the water that had once flown along the city's streets vanished from the landscape. An important turn in the fate of Kanazawa's canals was brought about by the city's 1968 Ordinance on the Conservation of the Traditional Environment. At a time when Japan was confronted with problems of pollution, environmental degradation and the destruction of historical cityscapes, triggered by economic growth and urbanization, the Ordinance was an expression of Kanazawa's commitment to preserve the quality and distinctiveness of its traditional natural and cultural environment, while reconciling them with urban development and modernization. The conservation and restoration of green areas and water surfaces as part of the city's traditional environment has been ever since one of the constant themes of urban policy in Kanazawa.

Kanazawa's interconnected network of 55 man-made watercourses totaling 150 kilometres in length has the potential to contribute to biodiversity conservation in the city as a basis for developing corridors through which birds, insects, animals and seeds can move across the landscape. In combination with the city's parks and gardens, they can serve as a green and blue infrastructure that is vital both for aquatic species and for species that need both land and water to survive.

In autumn, little life dramas are unfolding out of sight in the water of Kanazawa's canals. It is here that firefly larvae spend most of their lives, feeding on small river snails known as *kawanina*. Growing through autumn and winter, the larvae emerge from the water on a rainy spring night to bury themselves in the soft soil on the bank of the canal. Then, in May and June, adult fireflies come out of the ground, resting under leaves during daytime and lighting up at night to attract mating partners. As the lifecycle of fireflies shows, a concrete-wrapped canal is not enough to foster life. Various

other factors need to be taken into account to increase its ecological value, from the quality of native, layered vegetation, to control of light, noise and other disturbances.

Fireflies hold special connotations in Japanese culture, which has long celebrated their nocturnal irradiance. Along with blossom viewing in spring, moon and maple leaf viewing in autumn and snow viewing in winter, firefly viewing in summertime is an ancient custom which started as an aristocratic amusement. In the eighth-century poetry collection *Manyoshu*, the image of fireflies is used as a metaphor for longing and desire. Tenth-century essayist Sei Shonagon, a lady-in-waiting at the imperial court, wrote in her *Pillow Book*: "In summer it is the nights that are most beautiful. Not only when the moon shines, but on dark nights too, as the fireflies flit to and fro, and even when it rains, how beautiful it is". The names of the two most common species, the Genji and the Heike firefly, are based on a legend about two powerful feudal families of the twelfth century, which held that their spirits were still fighting out their battles in the form of fireflies. The larger Genji fireflies are named after the winning Genji clan, while the smaller Heike after their defeated opponents.

The affectionate care with which both the city government and the communities have engaged in the reintroduction of fireflies to Kanazawa's canals shows how culturally-valued species can attract people to become involved in conservation activities. After the firefly behaviour was meticulously studied, Kanazawa people proceeded to place stones on the canal beds in order to modify the water flow and create suitable spaces for the growth of the insects. Every summer, they shade the streetlights and postpone the habitual summer weeding of the canals until the firefly season ends. Children set out on expeditions throughout the neighbourhood to make an inventory of the fireflies as part of environmental education activities. Firefly watching groups approach the rails in silence, as hundreds of tiny jewels glow and pale, flying over the water. Centuries-old houses open the gates of their secluded gardens for visitors to enter reverently and witness in awe the love dance of the fireflies.

Once the firefly mating ceremonies are over, newly-spawn larvae slip back into the canal water. As they meander through the gardens, the canals create an intertwined landscape of green and blue networks that partake in the processes of life, from the microscopic to the enveloping. Autumn falls again on the small traditional gardens scattered throughout the city, and on Kenrokuen, where the Misty Pond, fed with the water of the Tatsumi Canal, reflects one more time the shifting colours of the maple leaves.

CITIES AND BIODIVERSITY

The quality of life in urban areas and the preservation of the diversity of life on earth are inextricably interconnected, yet the scientific understanding of how cities and biodiversity influence each other remains fragmented. Recently, it has been acknowledged that the wellbeing of urban residents depends on the correct functioning of ecosystems inside and outside cities, which in turn depends on maintaining biodiversity in those systems. Pouring fresh water for our morning coffees, enjoying a variety of tasty foods in our meals, or simply obtaining spiritual comfort by contemplating a landscape, depend ultimately on maintaining rich soils, good pollinators, crop diversity and healthy ecosystems, which in turn are products of biodiversity. It is also acknowledged that cities are net consumers of nature, as they obtain more benefits from the ecosystems and biodiversity outside their boundaries than from within. This urban appropriation of nature has multifaceted, sometimes contradictory, effects on biodiversity.

For instance, city governments, as opposed to states or international agreements, can be vital in effectively protecting biodiversity—for example, by maintaining green spaces, creating ecological protection areas, promoting green procurement and supporting urban-rural networks for sustainable food systems. However, urbanization can also damage biodiversity, both directly (e.g. by turning natural ecosystems into residential, industrial, or infrastructure spaces) or indirectly (e.g. through overexploitation or pollution of habitats).

Improving our understanding of the linkages between cities and biodiversity is especially important nowadays, as cities are undergoing profound transformations across the world. Globally, urban population continues to rapidly increase, and it is expected that an increasingly higher number of people will live in cities as they consolidate as attractive centres of economic opportunity and social progress. The opposite trend, however, is also relevant, that being shrinking cities resulting from population aging or economic decline, as observed in some places, including highly industrialized countries such as Japan. The relationship of an expanding city and a shrinking one with regard to biodiversity can differ significantly.

For example, a growing city may lose valuable peri-urban ecosystems in order to meet increasing housing demands (negatively affecting biodiversity), while a shrinking one can use abandoned spaces for greenery or agriculture (thus increasing urban biodiversity). Not only are land use issues important when considering cities and biodiversity; social and economic aspects also play a role. For instance, in some rapidly growing cities of the developing world, it is poor communities that account

for much of the population growth. This means lower per capita consumption rates (e.g. meat, fish, fuel, minerals, etc.) and thus, indirectly, less pressure on ecosystems and biodiversity when compared to affluent cities in the developed or rapidly developing world. For the latter, current consumption patterns of residents with increasing disposable incomes have been proven to have adverse effects on biodiversity through pollution, overexploitation or unsustainable use. For the urban poor, the issue that remains is that of ecological justice: limited access to the benefits of biodiversity and ecosystems might translate into vulnerability and further social exclusion—for example, from flooding or malnutrition.

Nature outside and within the city: Biodiversity, ecosystem services and ecological footprints

A concept that can help our understanding of the complex ways in which cities and biodiversity are connected is that of ecosystem services. "Ecosystem services" refers to the "benefits people obtain from nature" and includes the wide variety of different goods and services provided by ecosystems that are essential for human life. Four different types of ecosystem services have been identified: provisioning (food, fuel, fibres, water), regulating (climate control, air pollution removal, waste assimilation, flood control), supporting (habitats for species, soil formation), and cultural (recreation, traditions, spiritual) (MA, 2005). Because biodiversity is fundamental for the functionality of ecosystems—biodiversity makes ecosystems productive, resistant, resilient, and able to evolve (Elmqvist et al., 2003)—all the benefits our daily lives receive from nature are, either directly or indirectly, connected to maintaining biodiversity.

The realization that human wellbeing depends on having biodiversity-rich ecosystems is especially relevant for urban areas. City dwellers benefit from a myriad of different types of ecosystem services (MA, 2005; TEEB, 2010). For the most part, the services that cities obtain from "nature" come from spaces outside the city limits and, in many cases, from places far away. This is especially relevant for affluent cities, which tend to appropriate more "nature" than less affluent ones (Folke et al., 1997). For instance, the CO_2 emitted from urban centres as a result of transportation or industrial activities can be assimilated by forests located hundreds or thousands of kilometres away. The use that urban areas make of the ecosystems that provide the goods and services for their functioning is known as the urban ecological footprint (Rees and Wackernagel, 2008). The bigger the ecological footprint of a city, the more impact it has on ecosystems and/or biodiversity, thus posing risks of overexploitation and unsustainable use. However, the connection between cities and their surrounding ecosystems can also

function the other way around. That is, biodiversity can deteriorate not as a result of overuse, but also as a result of abandonment of traditional management practices. As beautifully illustrated by the recent Japan *Satoyama Satoumi* Assessment (2010), the depopulation of rural areas can have a negative effect on the biodiversity of traditional landscapes such as croplands, rivers, wetlands, forests and coastal areas, whose mosaic-like land use patterns and natural resource management practices have fostered biodiversity for centuries.

It is also worth noting that, although in quantitative terms cities obtain most of their ecosystem services and biodiversity from areas outside their boundaries, urban ecosystems also play an important role in city dwellers' wellbeing. For the general public (and even for planners and policymakers), the most obvious ecosystem services generated from within city limits are related to recreational or cultural activities (e.g. parks and other spaces for leisure, traditional celebrations or spiritual use). Other services, such as microclimate regulation provided by urban vegetation to control urban heat island, or waste assimilation in urban wetlands, may go unnoticed by the layperson, yet still be crucial for local wellbeing. Perhaps because the role of urban ecosystems and biodiversity in providing a multiplicity of benefits has been underestimated, urbanization processes invariably replace local "nature" with human-made infrastructure. For instance, light-reflecting paints on rooftops can be used to compensate for the cooling effects of lost vegetation, and waste treatment plants can be built to compensate for naturally occurring waste assimilation in wetlands and tidal flats. It is worth noting that this can lead to impoverished local ecosystem services and biodiversity, which in turn can reduce the ability of the city to obtain other benefits. Without enough "green" and "blue" areas, a city can become more vulnerable to floods, reduce carbon fixation capacity or lose valuable migratory habitats. Directly or indirectly, and whether in the short term or long term, reduced local ecosystem services and biodiversity will translate into reduced human wellbeing.

Homo Urbanus: Consuming nature for nurturing urban lifestyles

As shown above, the concepts of ecosystem services and ecological footprint are useful to understand some aspects of the connection between cities and biodiversity. Other variables also influence this relationship greatly, a very important one being lifestyle changes resulting from urbanization. It is broadly acknowledged that urbanization processes can significantly contribute to biodiversity loss by appropriating and/or degrading natural ecosystems for development purposes (McKinney, 2002). Yet beyond visible landscape changes through which concrete and steel structures replace former green or blue areas, the city brings about another less

visible—yet no less important—transformation, one related to the lifestyle of the urban resident: consumerism (Davis, 2000). The more affluent a city, the more ecosystem services it appropriates from outside its boundaries (Folke et al., 1997). Urban residents around the world with access to "disposable" incomes increasingly demand species, fuel, foods, energy and other natural goods and ecosystem services to fulfill their city lives. It is acknowledged that the patterns of consumption of industrialized, high-income countries cannot be sustained for the global population (McDonald et al., 2008). This poses a serious challenge, as the future of urban regions may be jeopardized if cities are not able to change the ways in which they relate to nature.

For the layperson, establishing a connection between urban lifestyle and biodiversity loss may not be so clear-cut. After all, our perceptions of biodiversity loss are deeply influenced by secondary information, as very few urban residents have the chance to experience directly and in depth what happens in the world outside the urban asphalt. For instance, when thinking about biodiversity loss we might recall the tropical rainforest, but not necessarily make the connection that the main cause for its disappearance is agricultural expansion (MA, 2005). Growing feed to meet the demand for meat in urban areas, or the expansion of energy crops to fuel the city, are major sources of land use change leading to massive biodiversity loss (IASTAAD, 2009). Among the multiple ways in which new urban consumption patterns can affect biodiversity, perhaps changes in food preferences are among the easiest to comprehend. For instance, increased meat consumption among affluent urban consumers can lead to cattle and feed expansion in distant places, which in turn has a negative effect on biodiversity through deforestation and habitat destruction (FAO, 2006). Another example is the increased demand for certain sea species (e.g. Atlantic blue fin tuna), with populations on the verge of collapse in some areas due to increased catching capacities of commercial fishing.

Cities providing ecosystem services to meet local tastes: Food

So far we have seen how cities depend on the biodiversity of ecosystems within and outside their boundaries to sustain their residents' wellbeing, yet also how urban life can pose a threat to those same vital systems. But do cities necessarily have to play that role? Are there any successful stories of city initiatives having a positive effect on biodiversity? And if so, how can we study them, and what lessons can be learned?

In order to explore those questions, and given the complex linkages between cities and biodiversity mentioned previously, the best way to illustrate how a promising

initiative could work is through an example that provides depth and breadth of understanding. Once again, food can serve this purpose nicely. Evidence obtained from around the world shows that cities can increase their provision of local ecosystem services in order to fulfill local taste while also reducing ecological footprints by increasing local food production. Terrestrial and aquatic urban ecosystems can not only be spaces of leisure, but also become areas for production. It is acknowledged that urban agriculture can provide multiple benefits for city residents, from access to fresh produce to community building or innovative employment opportunities (Pearson et al., 2010). In aquatic urban ecosystems, sustainable aquaculture and proper fisheries management can contribute positively to biodiversity conservation by providing local foods, creating employment and fostering technological innovation while reducing ecological footprints (Costa-Pierce et al., 2005).

In Tokyo, one of the biggest cities in the world, among intricate networks of railways, roads, residences and power wires, local urban agricultural production of vegetables equates to the average annual consumption of almost 700,000 people (BILA, 2010). Production includes renowned crop varieties such as the Nerima radish. Over 85 per cent of Tokyo residents prefer to have farmland in the city in order to secure access to fresh foods and preserve biodiversity. In Kanazawa, local efforts and the enthusiasm of some residents make it possible for traditional varieties of vegetables, including the famous Kaga vegetables, to be grown and sold across the city, providing consumers with nutritious foods that suit their tastes. The genetic diversity stored in the seeds of these vegetables, together with the habitats in which they grow and the knowledge of how to grow them, is a valuable source of biodiversity for the city and beyond.

Productive landscapes and the modern metropolis: Revisiting *satoyama* and *satoumi*

In recent years, rethinking cities as providers of ecosystem services through the sustainable management of their local biodiversity (from species to landscapes) for fulfilling urban taste and reducing footprints has resulted in some interesting concepts. The so-called "continuous productive landscapes" (CPLs) concept is emerging as a powerful planning framework for increasing local sustainability while reducing urban footprints. From the CPL perspective, the city adopts a compact form so its surroundings can be used for urban agriculture (Vilijoen, 2005). The CPL concept considers that growing food in cities can significantly decrease the need for industrialized production, extensive packaging and lengthy distribution from productive spaces (rural areas) to consuming ones (cities).

Even more recently, the concepts of *satoyama* and *satoumi* have provided inspiration for the integration of ecological production and cultural preferences when rethinking the modern sustainable city. The concepts of *satoyama* and *satoumi* refer to "dynamic mosaics of managed socio-ecological systems that produce a bundle of ecosystem services for human wellbeing" (Japan *Satoyama Satoumi* Assessment, 2010). Although the concept was created for traditionally-managed rural (including coastal) landscapes, there are lessons modern metropolises can learn regarding how to enhance biodiversity and ecosystem services for local wellbeing. For instance, it has been noted that *satoyama* landscapes in peri-urban areas can become important hotspots for ecological restoration and increased ecological production in order to fulfill urban demands for foods, energy and cultural services while revitalizing areas with declining populations (Cities and *Satoyama* Landscapes Symposium, 2010). Likewise, the *satoumi* concept can provide valuable insights for the planning of modern, sustainable coastal cities (Yanagi, 2005). Concrete examples on how *satoyama* and *satoumi* have inspired biodiversity-friendly initiatives at the city level can be drawn from the regional clusters' findings of the Japan *Satoyama Satoumi* Assessment. For coastal cities such as Tokyo, local environmental degradation resulting from urbanization has been reversed in recent years by decreasing water pollution, and local ecosystem services of the coastline are being brought back to the city, for example in the form of accessible beaches. Further, in the Kanto region, the Sambanse Lagoon area is now a model for urban environmental restoration. In Ishikawa Prefecture, green tourism and ecotourism are becoming popular, and citizens increasingly visit *satoyama* and fishing villages to enjoy biodiversity and ecosystems—gathering mushrooms, attending festivals or enjoying recreational activities such as diving or sea kayaking. Educational programmes on *satoyama* and *satoumi* landscapes are also being made possible with the participation of the non-profit/non-government sector.

Conclusion: Biodiversity-friendly cities on the global agenda

The discussion in this chapter has illustrated the way in which current cities grow and function and how this leads to unsustainable patterns of biodiversity use and ecosystem service appropriation. Fortunately, there is also evidence to show that there are new concepts and exciting opportunities ahead to overturn this trend. Nevertheless, there is still a long way to go to transform current urban areas into biodiversity-friendly spaces for human wellbeing.

One of the challenges of this transformation is related to the current international governance of biodiversity. Cities (and, more broadly, local governments) are not a

central part in the discussions on the Convention of Biological Diversity (CBD), which is the most important international mechanism for the preservation and sustainable use of biodiversity, as well as for the equitable benefit sharing of its components. This leads to lack of coordination with national governments (which are the parties in the CBD debates) and an absence of biodiversity mainstreaming within the urban agenda (Puppim de Oliveira et al., 2010). Despite these challenges, sub-national governments of several countries have developed their own action plans for biodiversity, incorporating the main contents of national policies but adapting them for their local communities (Pisupati, 2007).

In conclusion, cities around the world find themselves in a paradoxical situation with respect to biodiversity. On the one hand, they depend on the ecosystem services and biodiversity provided by nature, whether within or outside their boundaries. On the other hand, current urbanization and lifestyle trends are presenting major challenges to the effective preservation of the ecosystems upon which cities depend. This is especially relevant in today's conjuncture, with a world under global environmental change and a growing population close to 7 billion people, half of them currently inhabiting urban areas and many more in the decades to come. Yet, as history has shown, one could argue that the very nature of cities is that of appropriating natural (and human) capital in order to grow and function. Hope lies in the fact that cities are also extraordinary centres of knowledge creation and innovation. We should remain confident that, provided with adequate support, cities will be able to reverse this situation and play a key role in the improvement and sustainable use of biodiversity in the years to come.

BIODIVERSITY IN KANAZAWA

Assessing the status of biodiversity and the role of cities

The Secretariat of the Convention on Biological Diversity (SCBD) published its third Global Biodiversity Outlook (GBO3) in 2010, which compiles the most comprehensive, up-to-date information about the situation of biodiversity across the world, from genes to ecosystems, including main threats and conservation challenges. The report indicates that the target agreed to by the world's governments in 2002 of "achieving by 2010 a significant reduction of biodiversity loss at the global, regional, and national level" had not been met (GBO3, 2010). Overall, the five principal drivers of biodiversity loss (habitat change, overexploitation, pollution, invasive species and climate change) have either remained constant or increased. Moreover, the ecological footprint of the human population by-and-large increasingly exceeds the biological capacity of ecosystems.

Cities, as direct or indirect contributors to the five drivers of biodiversity loss mentioned above, must play a significant role in the conservation and sustainable use of biodiversity. Yet the depth and breadth of the linkages between urban areas and biodiversity, whether positive or negative, cannot be properly grasped by aggregated, global figures. Acknowledging the importance of deepening our understanding of these linkages, a GBO on urbanization will be carried out in the near future. In the meantime, because biodiversity is deteriorating rapidly and urban expansion is happening just as fast, it seems critical to enhance our knowledge on the status of biodiversity within cities, the main threats to its sustainable use posed by urbanization, and the main challenges and opportunities to replicate successful cases and reverse pernicious trends.

The sections below present some initial findings of research conducted in Kanazawa by UNU-IAS with regard to identifying the main local biodiversity features of terrestrial and aquatic ecosystems, major threats for their conservation, current opportunities for reversing negative trends or strengthening success stories, and major challenges for successfully engaging in those opportunities. The data presented focuses on the perception of several interviewees, including city and regional government officials and natural resources managers, including farmers and fishermen. Secondary data on some aspects of Kanazawa urbanization trends are also included for reference. The concluding section highlights general governance challenges and recommendations for biodiversity protection in Kanazawa based on the information collected from the interviews.

Terrestrial ecosystems in Kanazawa

Forests

Kanazawa lies at the intersection of two ecological zones: warm temperate broadleaf forests and cool temperate deciduous forests. As a result, the city's vegetation is a rich mixture of species characteristic of both warmer climates to the south and cooler northern regions. Of the city's forests, 23 per cent are national forests and 77 per cent are private. With forests and grasslands covering 60 per cent of the municipal area, the city has earned the name "Capital of Forests". The subalpine and mountain areas to the south and east of the city are rich in relatively undisturbed deciduous forests of beech, oak and birch, and are home to large mammals and birds of prey. At lower altitudes and on the hills adjacent to the urbanized areas, secondary forests—which have historically been managed for timber and other forest products—provide different types of habitats for species preferring more sunlit forest environments. These forests are interspersed with stretches of intra-mountainous cultivated land in a mosaic characteristic of the socio-ecological production systems known as *satoyama* landscapes. In addition, the forested terraces of the Asano and Sai Rivers reach deep into the centre of the city, connecting the forests of the surrounding hills with the green spaces in the urban area and providing important corridors that facilitate species movement across land and water environments. A stretch of coastal forests, consisting primarily of plantations of Japanese black pine and false acacia, extends along the sandy beaches, providing protection from wind and blown sand.

Unfortunately, over the past few decades, under-management of secondary forests—caused by declining economic viability, as well as depopulation and aging in intra-mountainous areas—has led to significant changes in the structure and functionality of these forests (e.g. proliferation of dark overgrown vegetation and expansion of trees to the detriment of former shrub or grass habitats), which in turn negatively affects the status of biodiversity (2, 9 – refer to list of interviewees).

In Kanazawa, much of the former deciduous and broadleaf evergreen forest has been replaced by conifer plantations for timber, driven by nationwide reforestation policies in the post-war period. *Sugi* (*Cryptomerya japonica*), the widest used conifer, is a species endemic from Japan, typical from mountains and hills in the south and central parts of the country, yet rarely spontaneous. Nowadays, conifers represent around 25 per cent of Kanazawa's private forests and are under the management of the municipal Agriculture and Forestry Department (2, 9, 10).

In recent years, wild boars, bears, Japanese serow and other wildlife have made their appearance in Kanazawa's peri-urban forests. As elsewhere in Japan, the managed mixed-species forests of *satoyama* used to act as a buffer between wildlife habitats and human settlements in the past. However, with decreased human presence and under-use, these woodlands became a suitable habitat for wildlife. Climate change could also be playing a role in the distribution of these species. Besides the economic loss of damage to nearby crops, wild boars are thought to have an effect on the overall biodiversity of the city forests, including through the altering of soil and interference with plant succession.

Kanazawa's forests have traditionally provided wood and non-timber products. To reverse under-management trends, the city is considering possibilities for re-establishing some of these linkages (e.g. traditional crafts, charcoal, fuel wood, renovated construction and public works materials) and for finding new uses (e.g. pellets, compost, recreational services) (2, 10). Forests are also connected to fresh water provision, which in turn is linked to traditional local industries such us paper and sake making (2). Such connections could be used to strengthen local production-consumption networks, ensuring that forests remain properly managed, which in turn can have a beneficial effect on biodiversity.

Clearly, government institutions and organizations can play an important role in promoting local consumption of forest products. In Kanazawa, the city government considers green procurement schemes—for example, to promote locally grown trees for public works and construction, and more recently, for bio-energy generation—as instrumental in maintaining the functionality of local forests (2, 10).

The Kanazawa City Government is also sponsoring different projects and programmes aimed at recovering forest habitats and preserving species, while also providing local livelihoods (9). Experiments aimed at the regeneration of native species of deciduous trees and biodiversity-friendly management practices such as forest thinning are also being carried out (2,9). The city also provides financing for new, innovative local businesses related to sustainable forest management (2).

The promotion of environmentally friendly tourism in traditionally biodiverse *satoyama* areas is another way to contribute to biodiversity conservation in Kanazawa's forests (6).

The future of local forests is ultimately linked to consumer preferences and cultural practices. If tastes and traditions that have determined the use of resources change, so will forests and their biodiversity (9). For instance, nowadays other materials are preferred over wood for construction purposes; if there is no demand, local production activities will not continue, which could in turn lead to abandonment or development, thus negatively impacting biodiversity (10).

Above all, lack of awareness about the importance of local forests as biodiverse habitats and for the provision of local ecosystem services poses a significant challenge for their proper management and conservation (10).

Agriculture

The presence of agricultural land, mostly rice fields, is a distinct feature of the landscapes surrounding the urbanized areas of Kanazawa. The sand dunes along the coast of the Sea of Japan are the city's largest area for vegetables, fruits and ornamental species production. As previously mentioned, traditional vegetables—which encompass the fifteen vegetable varieties including leaves, tubercles and roots known as Kaga vegetables, a local brand strongly supported by the city government—constitute a local source of genetic agricultural diversity. Approximately half of the total vegetable production in Kanazawa corresponds to Kaga vegetables (3). Organic and low-chemical production, although to a lesser degree, is also a significant feature of local agriculture (5), contributing to biodiversity protection mainly by avoiding the detrimental effects of chemicals in the ecosystem (e.g. soil, waters, trophic chain) (7). Perennials (e.g. fruit trees) are also found in some areas of the city. Local farming, even when employing conventional production methods (e.g. pesticides, hybrids) and accounting for a relative small area (especially in the more highly urbanized spaces of the city centre), still contributes to urban biodiversity by providing habitats for a variety of species, as opposed to other land uses such as buildings or infrastructure (12).

However, with the expansion of residential land use on to former agricultural areas of Kanazawa, habitats for a variety of species are lost and/or become fragmented. In addition, alien species typical of domestic environments (e.g ornamental plants) are introduced. Besides residential development, urban infrastructure is also a significant source of land use change and thus further habitat loss in the city (see "Urbanization process", right).

Urbanization process

Kanazawa has experienced a high rate of suburban development. Decades of urbanization and growth-oriented policy have caused the urban area to expand into the surrounding lowlands and hills, with an almost twofold increase from 1,610 hectares in 1975 to 2,112 hectares in 2008. The population doubled from 200,000 in 1920 to 400,000 in 1980 and reached 457,709 in 2009. High land prices in the city centre, increased reliance on car use and the relocation of businesses and factories to the peripheral areas also contributed to built area expansion and the associated phenomenon of 'emptying' of the city centre. Densely-inhabited districts (DID) increased from 3.5 per cent in 1960 to 12.7 per cent in 2005, accounting for 80.3 per cent of the city's population. Large-scale land readjustment projects have been undertaken in the peri-urban areas, leading to the conversion of natural and cultivated land to residential development, public facilities and loop roads. The most significant of these development projects has been the construction in the 1980s of the sub-centre zone, a corridor linking Kanazawa Station with the city's port, which replaced rice paddies in the plain area with large constructions and extensive impervious surfaces. The sub-centre was designed to stimulate business activities in the city and is expected to be given a boost by the opening of the Hokuriku Shinkansen in 2014.

Overall, conventional agriculture—involving chemicals such as pesticides or synthetic fertilizers, and/or hybrid seeds—is the dominant trend in local agricultural production, which poses a threat to the preservation of biodiversity at different levels, including genetic variability, soils, water systems and the trophic chain (6, 7). For example, shiitake mushrooms, traditionally grown on logs from spores carried by the wind, are now produced with patented spores in indoor settings.

In response to these challenges, the local government periodically conducts activities in schools to showcase the importance of agriculture for the city, emphasizing environmental aspects (3). By introducing traditional vegetables to young students, the city aims to make future citizens aware of the importance of preserving local agro-biodiversity.

Moreover, support for environmentally friendly agriculture is considered a win-win solution for local biodiversity preservation, as consumers of its products are for the most part interested in local varieties, and vice versa (7). However, environmentally sound agricultural practices and local variety conservation are not necessarily linked in Kanazawa at the moment: for instance, Kaga vegetables are a source of genetic diversity, yet not necessary chemical-free (8). Likewise, local organic production does not necessarily contribute to preserving local agricultural genetic diversity, as it may use varieties form distant locations.

Government officials and producers consider that support to environmentally friendly agricultural practices is key to preserving agriculture-related biodiversity (6, 8). Kanazawa has programmes to promote low-chemical agriculture (6) and a new organic agriculture promotion plan adopted in 2010 (3). In cooperation with the prefectural office and the farmers' cooperative, the city government is also editing manuals of best practices in soil management for different local crops (3). In addition to economic incentives, awards recognizing the work of dedicated producers can also be used as a mechanism for promoting desired biodiversity outcomes (13).

Making a substantial contribution to biodiversity conservation through agriculture in Kanazawa requires transforming consumption of local, biodiversity-friendly products from the current niche market into a mainstream one (7). For instance, most of Kanazawa's organic products end up in regional, national or even international markets, yet local, small-scale production needs alternative commercialization schemes (12). Allotment gardens (*shimin-noen*) and participatory harvesting (*taiken-noen*) are ways to involve urban residents in agriculture, which in turn can lead to strengthening consumer-producer networks and increased local environmental benefits from agriculture such as biodiversity (6).

One problem is that local varieties such as Kaga vegetables are overall less productive (per unit area) than conventional ones, and are also more expensive, as additional environmental benefits such as biodiversity are not discounted in the price (5). How to increase productivity of local environmentally friendly products, making them both mainstream and price competitive, remains a challenge. As of now, Kaga vegetables, organic, and low-chemical agricultural products are significantly more expensive than their conventional counterparts (5). Transitioning from a niche market to a mainstream one is key to making a difference in agriculture-related biodiversity (12).

Of concern is the fact that most of the people practising agriculture in Kanazawa today are part-time farmers, and most of them aging (3, 6). Consequently, great uncertainty exists regarding the preservation of agriculture-related biodiversity in the city. The extent to which agricultural areas will remain functional in the coming decades, which production methods will be employed or what kind of land uses they will transition into are relevant questions that are difficult to answer under the current demographic trends.

Moreover, traditional foods are no longer mainstream in the modern, fast lifestyle of the city, and an appreciation for local varieties is decreasing (8). For instance,

traditional recipes using Kaga vegetables are associated with longer preparation times, which represents a problem for regular consumption. The persistence of local taste preferences and food culture will be a decisive factor in the conservation of traditional vegetable varieties (8, 13).

Aquatic ecosystems in Kanazawa

Inland water ecosystems

Kanazawa has a rich diversity of freshwater aquatic ecosystems. In the mountainous areas of the city, streams and ponds associated with the traditional *satoyama* landscape provide habitats for aquatic species and, indirectly, for species of birds and other vertebrates who feed on them. Between the mountains and the highly urbanized areas, rice fields are the main providers of habitats for aquatic species. Rivers, consisting of two major and several smaller rivers, together with 55 canals totaling 150 kilometres in length, and the ponds characteristic of Japanese gardens, represent a diverse environment inhabited by fish, insects and water birds. Close to the city's northernmost boundary is the Kahoku Lagoon, a formerly brackish lagoon that became freshwater after two thirds of it was reclaimed for agricultural cultivation in the 1960s. The lagoon offers favorable conditions for aquatic fauna and flora, and provides a nationally important stopover for migratory birds.

When considering the threats to local biodiversity it is clear that river improvement works, concrete embankments and covered canals are just some of the urban infrastructure elements that contribute negatively to biodiversity, mainly through habitat loss (1).

Further, the decline of paddy field agriculture, especially in the mountainous areas, means that the biodiversity dependent on the aquatic habitats provided by paddies and irrigation ponds is also decreasing. Even more so, the fauna in higher levels of the food chain that depend on those feeding grounds, such as birds, is also declining (1).

Another problem is that widespread use of chemicals (whether for pest control or fertilizers) has detrimental effects on biodiversity along the trophic chain in inland water ecosystems, mostly in rice fields but also in rivers and canals (1). Although the water quality of inland waters in the city has improved significantly after the introduction of the public sewerage system, COD (chemical oxygen demand) levels remain high in some areas (e.g. Kahoku Lagoon), indicating high levels of organic pollution.

In response to these challenges, the City, sometimes in partnership with the private sector (e.g. through corporate social responsibility activities), engages in a series of urban infrastructure re-developments which, directly or indirectly, can have a positive effect on inland water biodiversity (1). Uncovering the canals in several portions along the urbanized area of the city, replacing concrete canal walls with natural river stones providing habitat for certain emblematic species such as fireflies, or adopting low-impact river infrastructure techniques that allow vegetation to grow between concrete structures are just a few examples. While aesthetics or other reasons are the primary drivers of some of these projects (e.g. uncovering the canals), biodiversity was the main target for others (e.g. recovering populations of fireflies).

Increasing public awareness about the linkages between preserving biodiversity in freshwater ecosystems and other environmental issues is crucial for the success of any intervention. In the case of the canals referred to above, for example, opening them implied exposing visible waste being carried downstream. Since canals provide a habitat for the firefly species, biodiversity preservation, waste management and restoration became inextricably linked in the public's perception (1).

As mentioned in the agriculture section above, the city has several programmes and projects for the promotion of environmentally-sound agriculture, which in turn can be expected to have a positive impact on the biodiversity of inland water systems.

Marine ecosystems

Kanazawa's beaches slope gently into the sea, forming a sandy sea floor under the shallow waters characteristic of the Kaga coastline. The sea off Kanazawa's coast shares the larger dynamics of the Sea of Japan, with warm currents from the south meeting cold currents from the north along the coast. As a result, the area is rich in a variety of fish and other marine species from both cold and warm zones. The sandy sea floor provides habitats for fish species living near the bottom of the sea, as well as for crabs and shrimp, which thrive on the abundant nutrients. Representative species include horse mackerel, flatfish, sandfish, deep-sea smelt, snow crab, squid and firefly squid, and deep-water shrimp (14).

Bottom trawling is the main fishing method practised by fishermen in Kanazawa in terms of number of fishermen employed, number of boats and catch size (3, 14, 15). According to the 2008 population census, there were 111 fishermen in Kanazawa engaging mainly in offshore and small-scale bottom trawling, which accounted for 1,687t out of 2,062t of total catches landed by Kanazawa fishermen (3). Bottom

trawling fishers obtain licenses from the national and prefectural governments to travel out of the local waters for which they hold common fishery rights, and along the coast towards Noto or to the shallow areas in the centre of the Sea of Japan, known as the Yamatotai Bank. The sea near Kanazawa is also the site of some gill-net and small-net fishing operations. Boats from all over Japan fish in the Sea of Japan, including purse seine boats and *ama* female divers from Noto, who engage in seasonal fishing in the Kanazawa area. Further, given that catches are often not landed at the port of origin makes catch figures for the city's waters difficult to estimate (14). As in the rest of Japan, fish catches in the Prefecture have shown a general declining trend over the past few decades (14). This decline is observed not only in catch quantities but also in terms of the size of the fish. For example, full-grown sardines (*ooba iwashi*), which were common in the past, are now no longer seen. The taste of the fish is also said to have changed (15).

Fisheries in Kanazawa have kept pace with the trends of increasing mechanization and adoption of technological innovation that is now characteristic of fishing industries worldwide. The diverse fishing methods used in the city in the past have been replaced by bottom trawling, which indiscriminately sweeps up whatever lies in front of the net. Even if the net mesh size is large, mud and fish accumulate in the net, preventing small fish from escaping. Fishermen believe there is a direct link between the practice of bottom trawling and the reduction in the size and abundance of fish (15).

In the past, local fisheries were closely linked with fish consumption in the city. Now, locally caught fish is sent to Tokyo and Osaka, where prices are higher (15).

Globefish and other new species are making their appearance in the nets of Kanazawas's fishers. Unusually abundant sandfish catches have been recorded in recent years. On the other hand, king crab, which was a common catch fifty years ago, has vanished from local waters. Massive outbreaks of gigantic jellyfish (*echizen kurage*) are threatening catches (15). Climate change might be one of the factors influencing the distribution of marine species, with southern species moving north. In terms of their socio-economic consequences, changes in species distribution can be expected to have both negative and positive impacts, with reductions in some valuable marine species and increases in others. Observations that even invasive species such as giant jellyfish can provide some benefits, such as food for crabs, suggest needs and possibilities for future adaptation.

Coastal infrastructure development also poses a threat to marine biodiversity. Large areas of Kanazawa's coastline have been reclaimed using sand and earth removed to enlarge the Kanazawa Port (15).

In response to the above problems, a variety of regulations aimed at fishery resource conservation have been adopted at different levels. Relevant national-level policies include the Total Allowable Catch (TAC) and the system of income compensation for fishers engaging systematically in resource management. The Ishikawa Prefecture has policies for fishery resource restoration, including for the development of fish hatcheries, release of fish juvenile, creation of artificial fish reefs and breeding grounds, and invasive species control. The Prefecture also promotes research on the sustainable use and enhancement of fishery resources, along with the improvement of fishery information systems (14).

The Fisheries Cooperative Association also establishes guidelines for voluntary resource conservation measures to be implemented by the fishers. These include restrictions related to harvesting seasons, the size of the harvested species and the mesh size. Protected areas where no fishing is allowed are set in the waters of the Kanazawa coast to ensure that snow crab is not depleted. Improved nets have also been introduced to allow crabs and small fish to escape. Release of juvenile fish is also practiced in Kanazawa, although now limited to only flatfish (14, 15).

The Ishikawa Prefectural Government has adopted measures for branding and marketing locally produced fish, as well as for promoting local markets. With a similar goal, the Women's Group at the Fisheries Cooperative Association organizes cooking classes focusing on the preparation of local species. They also promote the use of natural biodegradable soaps and detergents to reduce the pollution of fresh and marine waters and organise beach cleaning activities.

Unfortunatley, although resource management practices targeting commercially valuable species have been adopted by local fishers, there is little awareness of the importance of conserving marine biodiversity in general (14, 15). There is much less known about the coastal area than about *satoyama*, which in practical terms results in less biodiversity-focused activities being carried out in this area (1). Better knowledge of the potential of non-commercial species could be conducive to conservation initiatives (4).

Conclusions

Dealing with biodiversity issues efficiently and effectively would require better integration across the various sectors and departments of the local government, with regard to biodiversity issues. While not being unique to Kanazawa, sectoral fragmentation does come across as a major challenge for achieving biodiversity goals while developing the different programmes of each city department. For instance, the Environmental Department works in the urbanized area but not in the agricultural or forest areas, which fall under the responsibility of the Agriculture and Forest Department. In practical terms, this implies that biodiversity assessment, management, monitoring and evaluation is being done in fragments and thus not necessarily in a synergic way.

At present, Kanazawa does not have an overarching biodiversity policy, and biodiversity concerns are not at the core of the policy debate. This can result in ambiguous biodiversity outcomes. In some cases, improvements in local biodiversity can result as (unplanned) co-benefits from other projects. In other cases, potential biodiversity gains from a certain programme can end up being offset by another programme, even within the same department. Although many issues remain unknown regarding how to best integrate biodiversity targets into the local government agenda, a lack of effort in doing so (even at the evaluation level) will almost certainly lead to missed opportunities and conflicting targets across sectors.

The effective inclusion of relevant local stakeholders in the design, implementation and evaluation stages of the local government's biodiversity initiatives is key to achieving success. In Kanazawa, initiatives such as the branding of Kaga vegetables represent successful cases of stakeholder engagement in biodiversity conservation. However, further efforts will be needed to facilitate the effective engagement of other relevant stakeholders (farmers, fishers, forest owners) in the promotion of biodiversity-friendly practices.

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Interviewees

(1) Kanazawa City, Environmental Affairs Department, Environmental Policy Division.

(2) Kanazawa City, Agriculture and Forestry Department, Forest Development Division.

(3) Kanazawa City, Agriculture and Forestry Department, Agricultural Administration Division.

(4) Kanazawa City Central Wholesale Market, Fish Market.

(5) Kanazawa City Central Wholesale Market, Vegetable and Fruit Market.

(6) Hokuriku Regional Agricultural Policy Bureau.

(7) Kanazawa Daichi, Organic Produce & Products.

(8) Matsushita Seed and Plant Store.

(9) Kanazawa Forestry Cooperative.

(10) Kanazawa Wood Plaza, Miyano Factory.

(11) Shiitake Mushroom Producers, Ichinose Town, Kanazawa.

(12) Kanazawa Agricultural Cooperative, Soft Vegetable Promotion Group, Kakumoto Farm.

(13) Kanazawa Agricultural Cooperative, Iozan Spinach Promotion Group.

(14) Ishikawa Fisheries Cooperative Association, Headquarters.

(15) Ishikawa Fisheries Cooperative Association, Kanazawa Port Branch.

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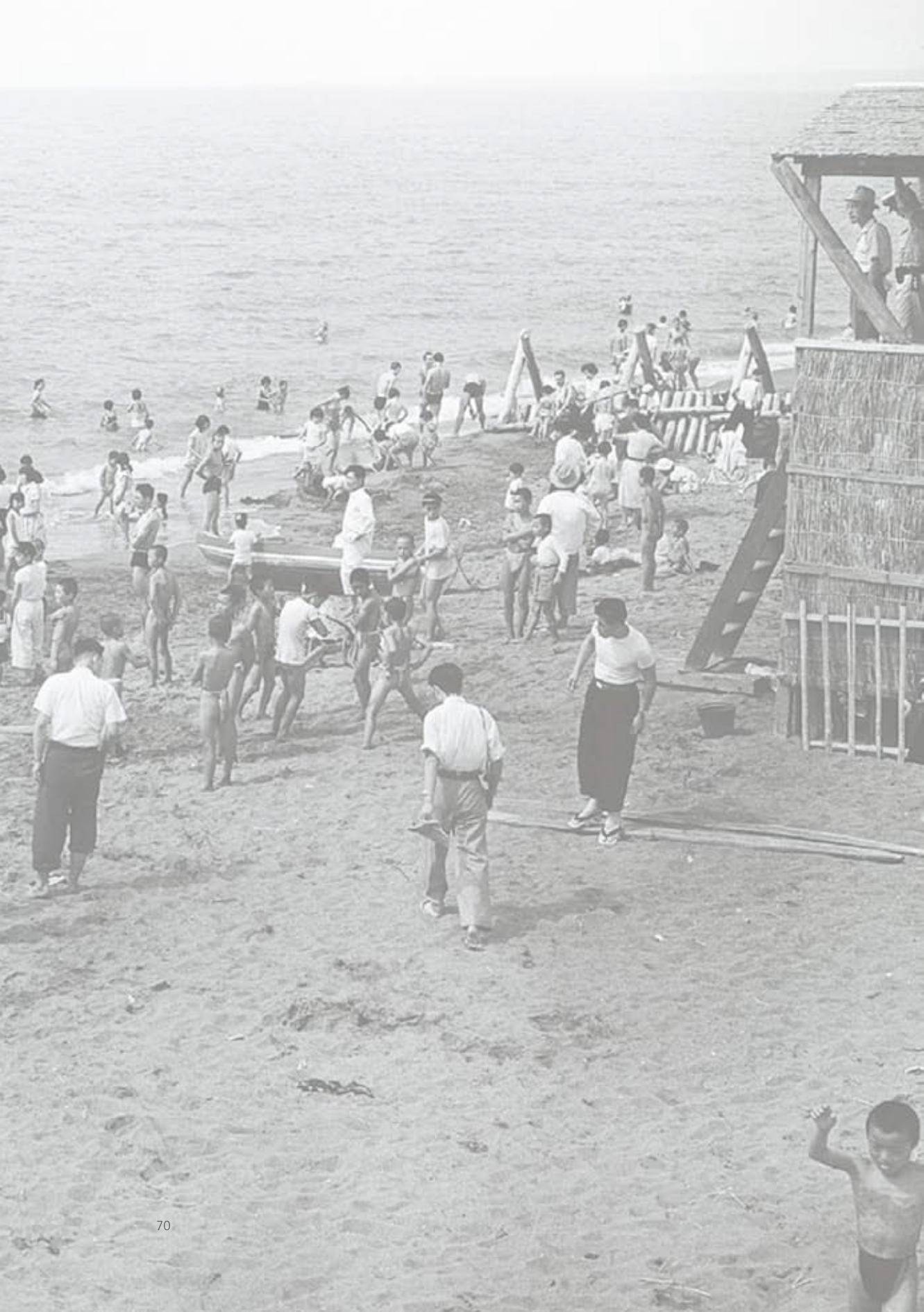

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